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The study was undertaken to learn about available materials and to provide some answers to difficulties in the use of new educational communications media in algebra instruction.

A bibliography of generally available media lists approximately 78 items under books, filmstrips, kinescopes, motion pictures, programed instructional materials, slides, and wall charts.

Instruction in ninth-grade algebra was visualized lesson by lesson over a period of a year. Tests were given to an experimental and a control class after each unit and were used to assess learning. Each lesson was evaluated, using a rating technique to indicate the level of learning during each minute of the lessons. An atlas of the profiles was prepared and is included in the report. It indicates what was being taught and provides a photograph of the class activities of the time. No significant increase in learning resulted from the visualized course. However, learning did not decrease in the manner reported in other studies of visualized courses. The learning profile technique for evaluating learning was refined and its applicability extended to less structured learning situations.

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new media for improvement of algebra instruction

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The University of the State of New York
The State Education Department
Bureau of Classroom Communications

NEW MEDIA FOR IMPROVEMENT OF ALGEBRA INSTRUCTION

John G. Church
Robert M. Brown
Loran C. Twyford

The study reported herein was supported in part by grant No. 7-30-044.00 from the United States Office of Education, Department of Health, Education and Welfare.

The University of the State of New York
The State Education Department
Bureau of Classroom Communications

June 1964

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FOREWORD

Algebra is considered by educational communications personnel to be one of the most difficult courses to provide with new educational communications media. The number of available materials is small and the opportunities for increased visualization are limited. It was with these challenges in mind that this study was undertaken. A year's course in general science was enriched with educational communications materials and evaluated in a previous study. This study describes the ways in which an entire course in ninth grade algebra was visualized and gives an evaluation of each lesson in the course.

A study with the intensity and duration of this one is very demanding upon the teacher who must work with the experimenters and teach the course according to the requirements of the study. Our appreciation is extended to Mr. Peter Blomerley of the Shaker High School, Newtonville, New York for his invaluable assistance with the project. No attempt was made to alter the basic course as it had been taught and it does not represent any special demonstration of curriculum content by the New York State Education Department.

This publication may be of interest to teachers and curriculum designers for suggestions about available visual materials and they may be able to obtain some estimate of the effectiveness of their use. The section on the relative effectiveness of new media and classroom activities may prompt a reconsideration of the value of current classroom practices. This study also revived the prospect for greatly improved instruction through substantial revision of classroom practices.

The first section deals with the overall experiment and describes and interprets the findings. The second section reports on the visualization efforts and includes profile evaluations of each lesson taught the control and experimental groups.

NEW MEDIA FOR IMPROVEMENT OF ALGEBRA INSTRUCTION*

John G. Church
Robert M. Brown
Loran C. Twyford

Summary Abstract

A course in ninth grade algebra was visualized lesson by lesson over a period of a year. Tests given to an experimental and a control class after each unit were used to assess learning. In addition each lesson taught the experimental and control groups was evaluated using a rating technique to indicate the level of learning during each minute of the lessons. An atlas of these profiles was prepared and is included in this report. It indicates what was being taught and provides a photograph of the class activities at the time. It was not possible to produce any significant increase in learning from the visualized course. However, learning did not decrease in the manner reported in several other studies of visualized courses. The learning profile technique for evaluating learning was refined and its applicability extended to less structured learning situations.

If it were possible to greatly increase the learning from a course through the introduction of a large number of visual and auditory materials, educators would greatly increase their demands for these materials. Efforts to effect this type of improvement have not been uniformly successful. Hundreds of studies have shown that carefully prepared films can produce sizeable increases in the learning from a lesson. Another hundred studies have shown that the learning from an entire course using numerous visual materials taught over television is seldom more effective than the regular non-televised course. In fact two studies have shown decreased learning.

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*This research was supported in part by Grant No. 7-30-044.00 from the United States Office of Education, Department of Health, Education and Welfare. The principal investigator was Loran C. Twyford. John Church was responsible for learning profile preparation and course improvement. Robert M. Brown was responsible for data analysis.

C. R. Carpenter and L. P. Greenhill at The Pennsylvania State University reported[1] that in two highly visualized courses learning was no greater and in one case was inferior to the regular lecture-blackboard presentation over television. Hope Klapper[2] also found decreased learning in a visualized television course.

This series of studies has as its general purpose the discovery of the reasons why learning in courses treated with new media is no better or inferior to regular instruction in light of the known superiority of certain visual materials used in these courses. The discovery and application of the methods for producing substantial increases in learning should greatly benefit education and strengthen the role of the new media in education.

Purposes of the study

There were several purposes in conducting the present study.

1. To use educational communications materials and equipment to increase learning in a year long algebra course and to measure the amount of improvement.
2. To determine the relative effectiveness of the various educational communications materials and other instructional methods used in a year long course in algebra.
3. To determine which media and combinations of media were most appropriate for the various units of the course in algebra.
4. To record and evaluate minute-by-minute all activities in a year-long algebra course and prepare an atlas of these activities.

5. To refine and extend the use of the learning profile evaluation technique.

METHOD

A course in ninth grade algebra was selected for the introduction of the new media for a number of reasons. Mathematics was one of the subject matter areas selected as a part of the National Defense Education Act of 1958. Algebra was a widely studied course which would provide numerous opportunities for implementation of the research findings. This course would represent a challenge for the application of the learning profile evaluation technique since few materials are available in this area and results can be accurately measured The profile technique can be applied easily in the ninth grade.

Design

The general procedure consisted of obtaining ratings of the amount of learning from a lesson or series of lessons using the profile evaluation technique. Educational communications materials were selected and introduced into the lesson when it was taught to a second class by the same teacher. Ratings of learning by the second class were then obtained by the same method to determine the extent of improvement. These ratings were used to assess the relative effectiveness of various media and classroom activities. Conventional unit tests were given to assess the amount of learning as it is usually measured. These unit tests indicated the extent to which the course had been improved through the use of visual and auditory materials.

Subjects

Two classes studying ninth grade algebra in Shaker High School of the North Colonie School District of New York participated in the experiment, during the entire 1961-62 school year. There were thirty subjects in each group; one group served as an experimental group for several units and the other was a control group. During the next few units the groups exchanged roles. The students had been found to be typical in ability and interests[3] in comparison to students in the rest of the state. The school had a teacher who taught several elementary algebra classes in a manner which would be considered typical. In addition, the teacher was willing to undertake the rather demanding tasks involved in adjusting to teaching with many new media and materials. The building lent itself to easy accessibility for equipment delivery and installation and was within commuting distance of the State Education Building offices. The administration was interested in cooperating in the experiment.

Before the formal study began, a pilot study was conducted in the Hackett Junior High School of the Albany Public Schools. Several classes were studied by means of the learning profile technique to assess the feasibility of a study in algebra. On the basis of success in this pilot study the present study was undertaken.

Ratings of learning

Two methods were used in this study for assessing the amount of learning that occurred during the course. Conventional testing was conducted at the completion of each unit of study. This gave some indication of the overall learning from the unit of study but it gave little information concerning the relative effectiveness of the various classroom activities and new media utilized by the teacher in the individual lessons. It is through analysis of classroom activities that there exists the opportunity to produce substantial increases in learning.

Conventional methods of measuring learning using pre and post tests are not practical for evaluating every activity that occurs in the classroom. Instead, a learning profile evaluation technique[4,5,6] developed by the principal investigator was used. It has been used on a limited scale since 1951 for evaluating learning from television programs, training device demonstrations and other educational programs.

The learning profile technique is a method whereby students using electrical summating equipment continuously rate on a five point scale the degree to which they believe they are learning at each instant in a lesson. Each student has a dial (Fig. 1) which he turns to indicate how much he believes he is learning. The dials of all students are connected in series and the summated response which is the total resistance of the series circuit is measured with an ohmmeter (Fig. 2). This combined learning response is plotted as the horizontal distance against the vertical axis of time. This is called a learning profile of the class lesson (Fig. 3). The method is ideal for locating strong or weak learning sequences during a class session because no tests need be prepared or graded, the results are available immediately and the method does not interfere to any extent with the instructional process.

At first glance this method for measuring learning would appear to be markedly inferior to conventional methods for measuring learning since it is based on the combined opinion of the raters. However, conventional testing methods also involve many intervening variables that are open to error. These involve such factors as item similarity to what is being taught, item difficulty, effect of distractors in multiple choice tests and the delay between learning and testing.

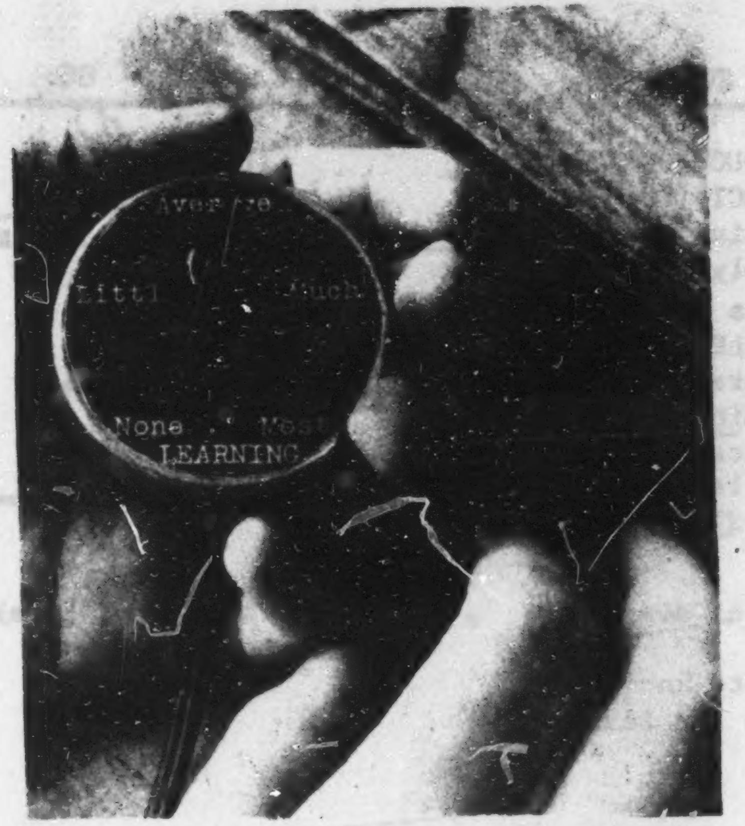

Average
Little
Much
None
Most
LEARNING

Figure 1. The potentiometer used provided a means of indicating the degree of learning the student was experiencing.

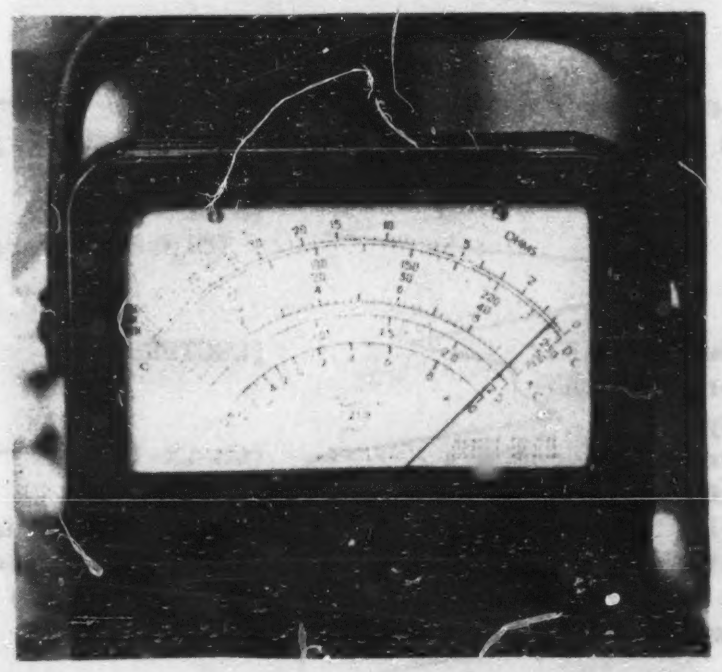
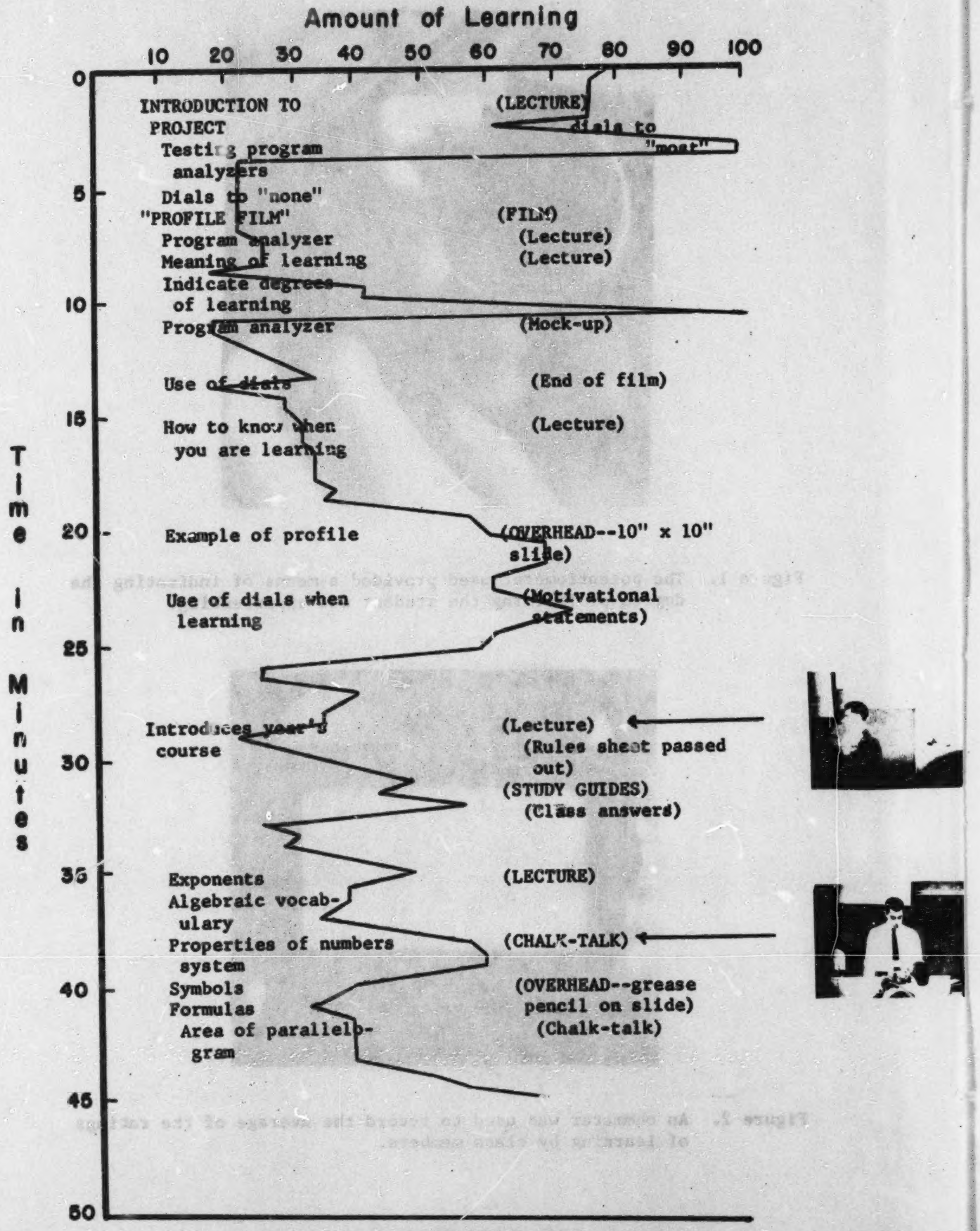


Figure 2. An ohmmeter was used to record the average of the ratings of learning by class members.

Sample Learning Profile



EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 2

The learning profile evaluation technique has been correlated with results obtained with pre and post tests. This correlation was .64[4] and is as high as can reasonably be expected between two learning measures. Almost as important is the high face validity of the technique. The profile peaks almost always coincide with lesson segment that one would estimate should have high learning potentiality.

The basic instructions for making ratings of learning were read to the students at the beginning of the course during a one hour training session. These instructions read as follows:

> "Each of you will find attached to your desk a dial attached to a wire. The knob on it is to be turned to indicate how much you are learning when information is presented during your class period. You are to rate the program on the basis of your own learning. Learning means that some change has occurred to you that we could discover by testing your knowledge before and after class. You may consider learning to be the acquisition of new facts which you understand well enough to remember at a later date. When information is presented that you already know you should report that you are not learning. Material which is too difficult may not be learned. Point the knob to the None end of the dial when you are not learning. Turn the knob to Most when you are learning at a maximum rate. The positions between represent intermediate degrees of learning. Will you now indicate you are learning at a maximum rate. Now, that you are not learning. Now that you are learning at an intermediate rate.

The last three sentences in the instructions were placed in the present order as a result of findings in the science study.

The training session involved showing a specially prepared ten minute film which presented the standardized rating instructions and gave some interpretation of these instructions. A film was used as an exercise in making ratings and then the group discussed reasons why they made high and low ratings at various points in the film. After a period of a week, intensive interviews were undertaken with ten students to discover any difficulty they might be having in making accurate ratings. Throughout the year additional training sessions were held when they seemed to be needed. Such extensive training is not ordinarily needed but was carried out in this instance to insure accurate ratings.

The lesson by lesson evaluation procedure took the following form. A graduate assistant sat in the back of the room where he recorded the meter readings every thirty seconds during the class period. He also recorded the content presented during that interval. The projector operator took photographs with a polaroid camera of the activities occurring at crucial times during the lesson. He also made tape recording of the class session. A special circuit was used with the meter which gave readings directly in percentage when adjusted for the number of students in the class.

After the data was collected it was plotted in the form presented in the last section of this report. At the same time the various activities engaged in during the lesson were listed, and the number of minutes for each and the average profile rating wererecorded. At the end of each unit and at the end of the year it was possible to determine how much time was spent on each activity and the average profile rating for that activity.

Control group evaluation

It was necessary to evaluate each lesson in order that the strong points might be retained and the weak points might be strengthened through the use of the new media. This evaluation was accomplished using the learning profile technique. The thirty students in the control group evaluated every lesson during the year. The educational communications specialist studied these evaluations to discover how the learning was presented to the experimental group.

Interpretation of control group learning profiles is an art that improves with experience. Peaks and valleys indicate that learning has or has not occurred but there is no information to indicate the reason why. There may be nothing to learn or the presented material may be confusing or too difficult. It was one of the duties of the educational communications specialist to study these profiles and to discover and understand why the peaks and valleys occurred. A knowledge of what was being taught was most important in reaching a decision. If little or nothing was being presented then learning would be low. Interviews with students gave clues as to the reasons for limited learning during some periods. The teacher was often able to explain the lack of learning. Tape recordings were analyzed to discover errors, confusion or lack of constructive learning experiences.

Adapting new media to the course

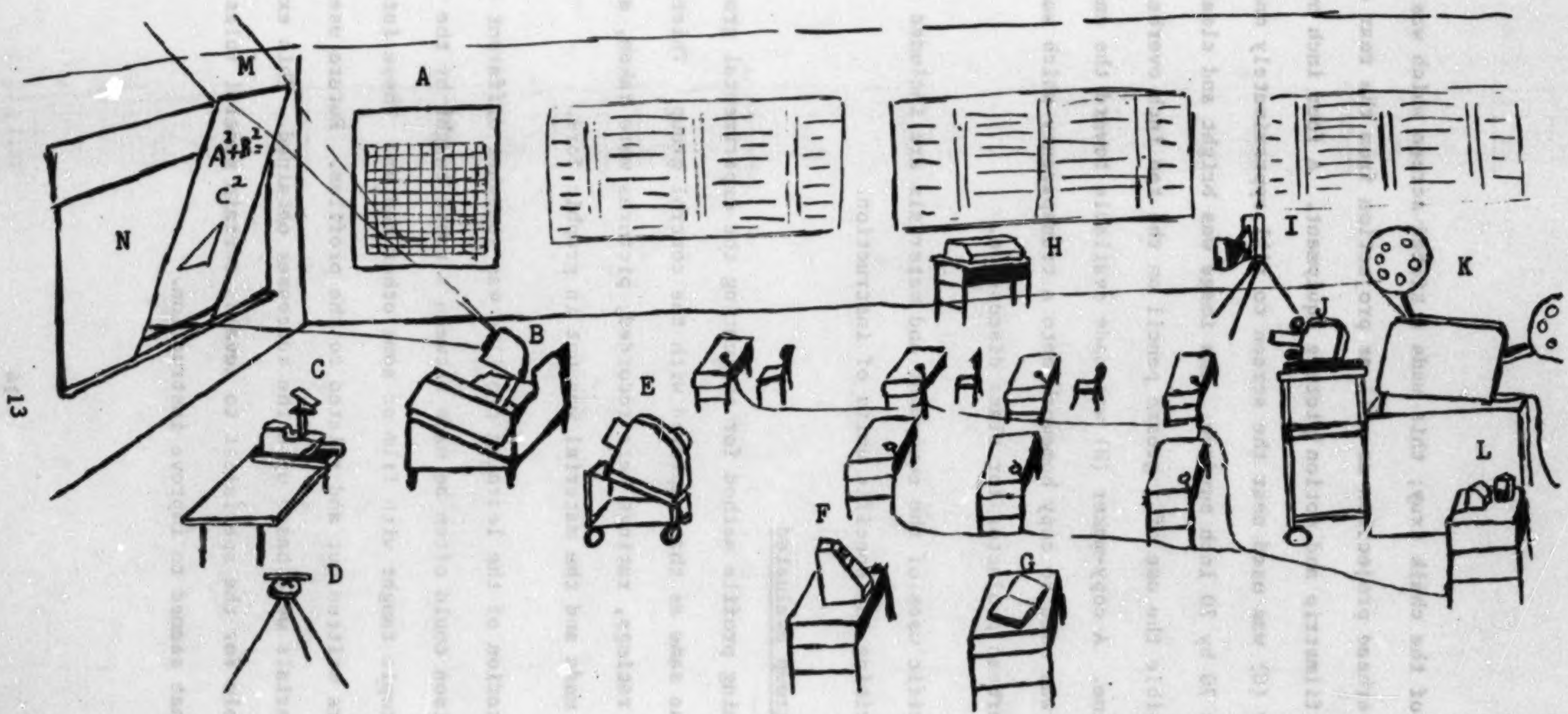
Once the control group learning profile or a group of profiles were analyzed the educational communications specialist prescribed materials and methods for improving instruction in the experimental class. The content of the algebra course differed from that of general science in that fewer isolated bits of information were learned in a single class session. Often it took several days to get across a single concept and the learning was probably acquired gradually. As a result the visual materials were more difficult to select or prepare which would improve these lessons. Manufacturers of visual materials and equipment were contacted during the preceding summer to make their products available for evaluation. Algebra textbooks were obtained for ideas suitable for the preparation of visual materials.

A "Bibliography of Learning Media for Elementary Algebra Surveyed in Connection with a Title VII Study" is located in the appendix. Starred items indicate media actually used. Many more materials were produced, but they were not listed since they are not generally available.

An artist prepared overhead transparencies, charts and other special materials. The overhead projector was used extensively to improve the instruction. Every visual aid that could be obtained was used as it was appropriate.

The educational communications specialist worked closely with the classroom teacher to assist him in the introduction of the new media. It was necessary to establish a reasonable amount of additional work for the teacher to do. If an excessive amount of preparation were required; the findings could not be considered to be transferable to other schools. When the improved instruction was presented to the experimental class the specialist had an opportunity to check on his ability to communicate new methods to the teacher by observing the actual methods used.

Figure 4 indicates the different types of equipment utilized in the study. Not all of the equipment was utilized at once, but the figure shows where it was placed when it was used. The screen (No. M in the figure) was suspended from the ceiling approximately five feet from the front wall. When pulled down for the experimental classes it was attached to hooks



A Wall Chart
B 10 inch Overhead Projector
C 3¼x 4 inch Overhead Projector
D Transit
E Opaque Projector
F Teaching Machine
G Programmed Materials
H Copy Maker

I Multiple Exposure Camera
J Filmstrip Projector
K 16mm Motion Picture Projector
L Profile Recorder
M Ceiling Suspended Screen
N Chalk Board

Fig. 4 Experimental Classroom

at the bottom of the chalk tray; this made a tilted screen which was convenient for overhead projection as well as projection from the rear of the room with filmstrip and motion picture equipment. A four inch overhead projector (C) was used near the screen to fill approximately one-quarter of its 70 by 70 inch surface. The image was bright and clear and this made possible the use of a grease pencil on the ten inch overhead (B) at the same time. A copy-maker (H) was made available toward the end of the year. It was used to copy homework onto a transparency which was then put on the overhead projector for class discussion.

More specific uses of the equipment and materials are included in the chapters describing the specific units of instruction.

Experimental group evaluated

The learning profile method for evaluating the experimental group was essentially the same as that employed with the control group. Thirty students made ratings, ratings were recorded, pictures were taken, a tape recording was made and the material was put in graphic form.

Interpretation of the learning profiles was somewhat different since a direct comparison could often be made between a topic taught by the teacher and the same topic taught with film or some other medium. These interpretations were written out and related to the profiles. Future uses of media and materials were based upon the successes obtained. This experience made it possible for the specialist to develop certain general rules or suggestions that seemed to improve instruction.

Objective testing of instructional units

Objective tests were given each group after each unit of study. These tests consisted of items prepared by the teacher and augmented by the educational communications specialist. Although the items contained visual problems they were not of the type of visualization used in general science. Although many algebra problems may be visualized there is a great body of its content that is of a verbal-symbolic nature. At any rate no attempt was made to prepare strictly visual or strictly verbal test items.

Experimental procedure

Both experimental and control groups were involved in a rather complex rating procedure which might restrict the transferability of findings to other schools. Also, it was impractical to visualize more than one class during the experiment. As a result the findings from testing are of more value for interpretation of progress made in improving the course than in demonstrating a significant difference in amount of learning.

The experimental and control groups each had thirty students who were tested after each unit. One class was taught during the first period and the second class was taught during the second period by the same teacher. The experimental and control classes were rotated at the middle of each semester and at the end of the first semester. Therefore each class served as an experimental group for the same amount of time.

Data to be examined

Test scores were obtained for each unit of instruction from all individuals in the experimental and control groups. These were used to determine yearly scores for the experimental and control groups.

The learning profiles contained an immense amount of data. Several of the many possible ways to analyze the data were used in this study.

The first and most reliable method of analysis of the profiles was that of determining the average profile amplitude for each of the media or classroom activities and of determining how much time each was employed. Every activity during the year was classified, (See appendix) timed and the average profile amplitude for films could be stated as a certain amount and this could be compared with any other activity. In order to make this comparison it was necessary to determine a zero point for the effective rating scale as contrasted with the total rating scale. This is required because ratings are relative and there is a tendency for ratings to be made about the center of the range. This effective zero rating was determined by taking the average amplitude of the lowest five minutes from every tenth profile. All classroom activities were then judged with respect to this base.

A second analysis of profile ratings was done on a unit by unit basis. It became evident that for each unit a different set of media provided the highest profile ratings of learning. For instance, a topic such as graphing offers greater opportunities for learning through visual media by its very nature than a more abstract unit involving computational skills such as functions.

A third analysis of profile ratings was concerned with profile peaks. The interpretation of an analysis of the peaks of profiles is somewhat different from an analysis of profile average amplitudes. The peak indicates the maximum potential for learning. Unless this peak amplitude is maintained for a sufficient period of time it is of limited value in instruction. Thus, analysis of profile peaks indicates potentially valuable educational communications media. Analysis of profile peaks permits one to discover learning effects that might be lost in the averages of profile amplitudes. Nevertheless, momentary learning peaks are not as important as sustained learning and recommendations based upon analysis of peaks is necessarily limited. Each profile was reviewed and the highest peak for the class period over 60% was utilized for the analysis.

Unit	Mean Score	
	Control	Experimental
Addition and Subtraction	80	77
Multiplication and Division	80	77
Functions and Literal Equations	71	75
Graphs	77	80
Linear Equations	80	77
Special Products and Factoring	82	85
Fractions	81	82
Equations and Problems	73	75
Exponents and Radicals	80	74
Quadratic Equations	75	80
Indirect Measurement	82	79
Average of Means	78.3	78.3

Table I. Mean Scores on Algebra Unit Tests

RESULTS

Learning by the experimental group as measured by unit tests was found to be identical to that of the control group. Table I lists the units and the mean scores.

Table II gives the amount of time spent on various classroom activities including those involving the new media. Writing on acetate which was projected with the overhead projectors was utilized the most--1196 minutes. The use of models, mock-ups, objects, and teacher-made 10"by 10"slides took less than twenty minutes. Table III gives similar information for the control group.

Table IV lists the ratio of effectiveness of thirteen algebra classroom activities as determined by the ratings of learning by the students. These were activities in which the experimental group spent more than one hour during the year. This table indicates that programed instruction is 3.81 times as effective as the activity in which the teacher tries to get the pupil involved in a problem situation. The table also gives the ratio of effectiveness between any two of the thirteen new media or classroom activities. It should be kept in mind that these ratios of effectiveness were based upon one teacher's performance in teaching algebra. Although the teacher taught algebra in a typical manner with the new media, one could expect some variation in the manner in which media are employed.

Table V indicates which media had the highest profile ratings for each unit. The media marked with a (1) had the highest average rating of learning and that with the fifth highest was marked (5). It can be seen that no one medium was most effective for every unit. Only the category of "questions by students" failed to rank in the upper five of any of the units.

Experimental Group	**No. of Minutes**
Writing on acetate on overhead	1196
Individual Study	655
Test	615.5
Chalk Writing	492.5
Lecture	441.5
Locally made 10" x 10" slides	329
Questions to Class	295.5
Group Tutor Device	257.5
Teaching machines with teacher assisting small groups	248.5
Test Review	107.5
Filmstrips (35 mm)	105.5
Involvement	89
Questions by Individual Students	71.5
Opaque Projection	52
Programed Instruction Materials	49
Motivational statements	42
Students working problems on board	39.5
Wall Charts	34.5
Recitation	32
Films	30.5
Joking	20.5
Recordings	17.5
Group Discussion	15.5
Film Stopped on Single Frame	13.5
Teacher made 10" x 10" slides	11
Introduction	8
Teacher experiments and demonstrations	4.5
Models and mock-ups	4.5
Objects	4
Text and other book illustrations	4
Nomenclature	1.5

Table II. Classroom Activities Ranked by Time Used (Experimental Group)

Item	No. of Minutes	Percentage of Total Time
1. Chalk Writing	2192	34.41
2. Individual Study	807	12.67
3. Test	750	11.77
4. Questions to Class	708	11.12
5. Lecture	577.5	9.06
6. Questions by Individuals	183.5	2.88
7. Students working problems on board	129.5	2.03
8. Involvement	68.0	1.07

Table III. Classroom Activities Ranked According to Amount of Time Employed (Control Group)

	1 15.43 Programed Instruction	2 9.84 Test Review	3 9.63 10 x 10 slides	4 9.27 Filmstrips	5 8.59 Writing on overhead	6 7.06 Chalk writing	7 7.06 Questions to class	8 6.98 Group tutor device	9 6.73 Individual study	10 6.70 Lecture	11 4.72 Questions by students	12 4.16 Tests	13 4.05 Pupil involvement
13 Pupil Involvement 4.05	3.81	2.42	2.37	2.29	2.12	1.77	1.74	1.72	1.66	1.65	1.17	1.03	1.00
12 Tests 4.16	3.71	2.36	2.31	2.23	2.06	1.73	1.70	1.68	1.62	1.61	1.13	1.00	
11 Questions by students 4.72	3.27	2.09	2.04	1.96	1.82	1.52	1.50	1.48	1.43	1.42	1.00		
10 Lecture 6.70	2.30	1.47	1.44	1.38	1.28	1.07	1.05	1.04	1.00	1.00			
9 Individual study 6.73	2.29	1.46	1.43	1.38	1.28	1.07	1.05	1.04	1.00				
8 Group tutor device 6.98	2.21	1.41	1.38	1.33	1.23	1.03	1.01	1.00					
7 Questions to class 7.06	2.18	1.39	1.36	1.31	1.22	1.02	1.00						
6 Chalk writing 7.18	2.15	1.37	1.34	1.29	1.20	1.00							
5 Writing on overhead 8.59	1.80	1.15	1.12	1.08	1.00								
4 Filmstrips 9.27	1.66	1.06	1.04	1.00									
3 10 x 10" slides 9.63	1.60	1.02	1.00										
2 Test review 9.84	1.56	1.00											
1 Programmed Instruc. 15.43	1.00												

Note: Central figures indicate how many times the activities at the top are more effective than the activities at the left. Figures associated with each numbered item are the average corrected profile amplitude for that item.

Table IV. Relative Effectiveness of Thirteen Algebra Classroom Activities as Determined by Ratings of Learning (Experimental Group)

ALGEBRA UNITS

MEDIA*	Functions	Graphs	Linear Eq.	Factoring	Fractions	Equations	Exponents	Quadratics	Indir. Measurement	Revie
Lecture	2**		1						3	2
Questions to Class	3					2		4	2	
Ques. by Students										
Individual Study	1					4				3
Filmstrips		5					4			
Local 10 x 10 Slides		3	3			5			4	
Recordings							3			
Wall Charts							1	2		
Objects										1
Chalk-Writing	5	4	4		1	1				4
Films		2								
Group Tutor Device					3		2	1		
Writing on Acetate	4				2	3	5	3	5	
Opaque Projection			2							
Text Illustrations									1	
Students write on bd.		1								
Teaching Machines				1						
Small Group Instruc.				2						

Table V. Communications Media Rated as Most Effective by Units - Experimental Group

*This does not imply that all media were used in every unit. Definitions of the media are included in Appendix

**Numbers refer to first, second, etc. rank of the most effective media.

Not the least of the results of this study was the demonstration that the profile rating technique can be employed to some advantage in a course such as algebra. Learning of facts is not so specific as is the case in general science. This makes the task of rating learning that much more difficult. The revised instructions to the student as stated earlier concerning his rating task reduced the need for making corrections in profile amplitude to a minimum. The photographic recording of classroom activities and the recording of classroom sounds on tape became a routine in this study.

Table VI lists the amplitudes of the peaks of learning profiles higher than the sixty percent level. Twenty eight percent occurred when chalk-talk was employed. The use of the overhead projector produced 26 percent of the peaks. Overhead slides also produced a number of peaks which amounted to 17 percent of the total number. This analysis of profile peaks does not necessarily mean that a high level of learning was maintained but that the potential for high level learning exists. Table IV listing average amplitude of learning for any medium is probably a more important index of media effectiveness.

MEDIA--	Chalk-talk	Overhead with grease pencil	Overhead slides	Group Tutor Device	Lecture	Programed Study Sheets	Filmstrip	Film	Kinescope	Individual Study
Amplitude of profile peaks	79	79	70	66	73	68	66	61	63	70
	73	74	68	65	65	68				
	70	72	67	62	62					
	69	60	67	60						
	68	66	64							
	64	64	63							
	64	62	62							
	62	62	60							
	62	61								
	62	60								
	61	60								
	60	60								
	60									
Average	65.7	65.75	65.1	63.2	66.7	68	66	61	63	70
Percentage of profile peaks	28.3	26.1	17.4	8.7	6.5	4.3	2.2	2.2	2.2	2.2

Table VI. Peak Ratings for Each of the Media

DISCUSSION

It would be desirable to be able to say that the introduction of visual materials into this course resulted in greatly increased learning but this was not the case. Although the sample studied was not a large one and only one teacher was involved in the study there was still little indication of greatly improved learning.

By design, this study did not just measure overall effects. It measured, using a novel technique, the relative differences of various classroom teaching methods. Some were quite effective and some were quite poor. It now appears, although it has not been proved in this study that educational communications specialists must make a stronger effort to utilize only the most effective media and to reduce the time spent with the less effective media or classroom activities.

The low significance results of this study and the previous one in general science caused the research staff to spend a very great amount of time analyzing possible reasons for the lack of increases in learning and to formulate studies to demonstrate how learning might be increased. These studies are reported in a separate publication.

The discussion of instructional efficiency reported in the study of general science applies equally well to this study. There is little doubt that some of the media introduced into this course were more effective than conventional instructional methods. It is also probable that many less effective classroom activities were carried out. The net effect may be no overall increase in learning. We need to capitalize on any learning gains we attain and redouble our efforts to increase learning.

In this report the ratings of learning have been treated as if they are equivalent to learning gains as measured by tests. They may be, but the learning profile technique is too new for us to be certain. It seems advisable to check the more striking of these findings with the more conventional methods of measuring learning.

In another study* supporting this project it was shown that as much as 85% of learning from a course of instruction may be derived from activities other than the teacher's lecture. If a major portion of learning in this algebra course is learned from homework exercises, we might have an explanation for the results that were obtained. Further evaluations of television and various educational media should take this factor into account.

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*A Comparison of the Relative Effectiveness of Four Methods of Teaching Ninth Grade General Science, Ralph Smith and Hildreth H. McAshan.

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5. Twyford, Loran C., "Profile Techniques for Program Analysis", Audio Visual Communications Review, Vol. 2, No. 4, Fall 1954, pp. 243-262.

6. Merrill, I. R., Application of Profile Techniques for Training Aid Evaluation, Technical Report; NAVTRADEVCEN 602-11-1 U.S. Naval Training Device Center, Port Washington, L.I., N.Y. Jan. 1959, pp. 1-48.

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Part II

ATLAS OF LEARNING PROFILES
CONCERNING
NEW MEDIA FOR IMPROVEMENT OF ALGEBRA INSTRUCTION

1961-1962

by

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FOREWORD

The project at Shaker High School was carried out by Dr. John G. Church who was responsible for selecting the educational communications media utilized, for the collection of the data, and for presenting it in the form of this Atlas of Learning Profiles.

The project could not have been completed without the excellent co-operation of State Education Department and school district officials.

I. FACTORS AFFECTING INTERPRETATION OF RESULTS

The various write-ups in the Introduction as well as the analyses of units all contribute to interpretation of results of the study. This section includes some special factors which deserve attention.

Objectives in Algebra

Analysis of the course objective revealed that they were essentially aimed toward preparing the students for additional mathematics courses. There was no serious pursuit of goals related to making practical applications of algebra. The majority of the students were taking the course to meet entrance requirements for college where they could major in a non-mathematical subject. In spite of the mathematical emphasis in the course some students would see in the study of time-rate-distance problems the possibility of utilizing algebra as a tool in the formulation of generalizations.

An important objective of algebra is to present it as an extension of arithmetic, but this was not achieved in the normal classroom approach (which by the nature of the study was reflected in the experimental group presentation) since the main references made to arithmetic by the teacher were that (1) it is different from algebra, and (2) he was not skilled (or too concerned) with mathematical computations.

The objective of algebra as a collection of puzzles was pursued to a degree. Some students rallied to this approach by pursuing the working out of equations with the enjoyment of the "game" itself as the main goal. However some opportunities for puzzles were intentionally by-passed by the teacher.

An important goal which was pursued during this and the previous school year was the development of algebra as a language for quantitative relationships. There were, however, few suggestions to show how this language can be used in everyday lives by non-technically trained people.

Student Interests

A review of the profiles for the year revealed that student interests were not considered in determining control class content--which was the basis of content in the experimental classes. This probably contributed to a lack of enthusiasm for the subject.

A publication[1] (of which one of the teachers in the school where the study was conducted was an author) of a study of the interests of junior high school students was reviewed. The choices of occupational interests on the part of the boys were: engineer, athlete, mechanic, teacher, and doctor[2]; girls' occupational choices were, in rank order: teacher, secretary, nurse, housewife, and beautician. The academic content of the class hence would be of interest to the students who planned to be teachers but interests of the other students were not touched upon except in a few isolated instances. For instance, in the study of indirect measurement a prospective engineer would have been able to learn the use of the sextant and some of the principles of surveying. The broader objectives of algebra which would have been a concern of persons planning to go into other occupations were seldom, if ever, touched upon.

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[1] Charles W. Fowler, Paul F. Hooker, M. Lee Upcraft, "Interests of Junior High School Students" Center for Field Services, State University College of Education, Albany, New York. 1961. 108 pp.

[2] Ibid: page 39.

Teacher Philosophy

The role of the teacher in the view of the teacher may have been expressed by him when he told the class when involved in selecting a candidate to be teacher for a day (a school requirement for all classes) that the person selected would "have to teach the class and the students would have to listen."

Thus the philosophy of the teacher which had been expressed in his actions, was expressed in words. It was the idealistic philosophy that teaching involves pouring information into students. Most learning research has not supported this philosophy.

BIBLIOGRAPHY OF LEARNING MEDIA FOR ELEMENTARY ALGEBRA SURVEYED IN CONNECTION WITH TITLE VII STUDY

The communications media listed in this bibliography were surveyed for possible utilization in a research study[1] conducted by the New York State Education Department for one school year in algebra. The media set off by asterisks were evaluated in the study. Only media generally available are included. Media produced by the New York State Education Department specifically for the project are consequently not included; however such media were on display in the Division of Educational Communications.

In spite of many communications media being available for certain parts of the algebra course of study, classroom teachers and supervisors have found great difficulty in finding these since there is no single centralized listing of films, filmstrips, programs, and the various other types of media. The difficulty of finding separate listings and reviewing them to find pertinent materials has been adequate to reduce the amount of utilization of new media in the classroom.

No indication is made in this bibliography as to whether the media were effective or ineffective. The bibliography will make a convenient reference for the classroom teacher seeking communications media which he can evaluate himself as to their effectiveness for his particular classes.

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[1] United States Office of Education Grant #7-30-044, "New Media for Improvement of Mathematics and Science Instruction."

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Teachers Commentary, Pts. I & II. Connecticut: Yale University Press. Accompanies School of Mathematics Study Group Materials.

What Does Research Say About Arithmetic? Washington, D.C., Association for Supervision and Curriculum Development, 1958.

Filmstrips

Addition & Subtraction of Signed Numbers. Society for Visual Education. 1948. 46 frames. black and white. (Basic Algebra series).

(The) Arithmetic of Algebra. Jam Handy Organization. n.d. Approx. 55 frames. black and white. (Kit III - Algebra Series).

Equations & Formulas. Jam Handy Organization. n.d. Approx. 55 frames. black and white. (Kit III - Algebra Series).

Exponents & Logarithms. Jam Handy Organization. n.d. Approx. 55 frames. black and white. (Kit III - Algebra Series).

Five Keys to Math. Jam Handy Organization. n.d. Approx. 55 frames. black & white. (Kit I - Arithmetic).

Graph Uses. Jam Handy Organization. n.d. Approx. 55 frames. black & white (Kit IV - Graphs).

*Graphing Equations. McGraw-Hill. 1961. 36 frames. color.

Graphs. Society for Visual Education. 1948. 54 frames. black & white. (Basic Algebra series).

Grouping Symbols & Order of Operations. McGraw-Hill Book Company. 1952. 34 frames. black & white. (Mathematics Series)

*Indirect Measurement. McGraw-Hill.

*Inequalities. McGraw-Hill. 1961. 20 frames. (Modern Algebra Series.) Color.

Introduction to Equations. Society for Visual Education. 1948. 57 frames. black & white. (Basic Algebra Series).

*Introduction to Signed Numbers. Society for Visual Education. 1948. 43 frames. black & white. (Basic Algebra series).

Multiplication & Division of Signed Numbers. Society for Visual Education. 1948. 49 frames. black & white. (Basic Algebra series).

Order of Operations. Jam Handy Organization. n.d. Approx. 55 frames. black & white. (Kit I - Arithmetic).

*Plotting Graphs. Jam Handy Organization. n.d. Approx. 55 frames. black & white. (Kit IV - Graphs).

Positive & Negative Numbers. Jam Handy Organization. n.d. Approx. 55 frames. black & white. (Kit III - Algebra series).

Problem Analysis. Jam Handy Organization. n.d. Approx. 55 frames. black & white. (Kit I - Graphs Series).

Square Root & Cube Root. Jam Handy Organization. n.d. Approx. 55 frames. black & white. (Kit I - Arithmetic series).

Systems of Equations. McGraw-Hill Book Company. 1952. 30 frames. black & white. (Mathematics series).

Thinking in Symbols. McGraw-Hill BookCompany. 1952. 27 frames. black & white. (Mathematics series).

*Variables & Coordinates. McGraw-Hill Book Company. 1952. 33 frames. black & white. (Mathematics series).

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Math 9 - Algebra. 88 kinescopes. teacher-Dorothy Geddes. New York State Regents Educational TV Project. 1959-60. 40 min.

Math for Teachers. 89 kinescopes. teacher-Harry Ruderman. New York State Regents Educational Television Project. 1959-60. 30 min.

Modern Algebra. Learning Resources Institute. 1961. 80 lesson course 30 min. each. black & white.

Motion Pictures

A Day Without Numbers. Wayne State University. n.d. black & white.

Addition & Subtraction of Rational Numbers. Modern Learning Aids. n.d. 31 min. black & white.

Algebra in Everyday life. Coronet. n.d. 11 min. black & white.

*Algebraic & Complex Fractions. Modern Learning Aids. n.d. 29 min. black & white.

Areas. Knowledge Builders. n.d. black & white

*Axioms in Algebra. International Film Bureau. n.d. 13 min. color.

Donald in Mathmagic Land. Walt Disney Productions. n.d. 26 min. color.

*Electronic Computers and Applied Mathematics. Colburn Film Distributors, Inc. 1961. 28 min. color.

*Equations and Graphs of the Parabolas. Modern Learning Aids. 1960. 29 min. black & white.

*(The) Language of Graphs. Coronet. 1948. 13 min. color.

*Math Peep Show. Charles and Roy Eames for IBM. 1961. 10 min. color.

Multiplication of Rational Numbers. Modern Learning Aids. n.d. 31 min. black & white.

Patterns in Mathematics. McGraw-Hill. n.d. 14 min. black & white.

*Quadratic Equations. Modern Learning Aids. n.d. 29 min. black & white.

Radicals and the Real Number System. Modern Learning Aids. n.d. 29 min. black & white.

*Solving Equations of Fractional Form. Modern Learning Aids. n.d. 30 min. black & white.

*Solving Simultaneous Linear Equations. Modern Learning Aids. n.d. 29 min. black & white.

*Special Products and Factoring. Modern Learning Aids. n.d. 31 min. black & white.

*Symbols in Algebra. Coronet. n.d. 11 min. black & white.

Symmetry. IBM. n.d. sound. min. black & white.

(The) Mathematician & The River. Educational Testing Service. n.d. 19 min. black & white.

"Thinking" Machines. Educational Testing Service. n.d. 19 min. black & white.

*Variation - A Lesson in Reading. Modern Learning Aids. n.d. 26 min. black & white.

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College level. Testing collected 12/61. (College Division).

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Associates, Inc., Course I.

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Algebra I (Temac Programmed Learning Materials) Encyclopaedia
Britannica Films. 1961. pp. 569-673.

*Teaching Materials Corporation. "Simultaneous Equations" Unit II
of Fundamentals of Algebra Part II. Grolier. 1961. 338 frames.

Slides

*(The) 3-D Classroom. John Haverstick. 10" slide. black & white.

*8" slide. Ozalid. Series 1-32. 2 overlays. plastic slide.
black overlay with blue, overlay 2 - orange. 1961. Robert
Brady Co.

*Binomial Theorem. B-5-6. 10" slide. Tecnifax Corp., Holyoke, Mass.
4 colors.

*Binomial Theorem. B-45-6. 10" slide (reveal). same source.
3 colors.

Coordinate System. Welch Manufacturing Co. n.d. 10" slide.

Wall Charts

Chalkboard Graph Chart. Welch Manufacturing Co. 1958. 40" x 60"
black and white.

Graph Chart. Rand McNalley Co.

ACTIONABLE ITEMS

The following items were utilized in recording data via learning profile techniques. A particular class activity might be recorded under more than one category.

1. INTRODUCTION - refers to explanations of what is to be included in the lessons for the day or in future classes and explanations concerning how the new topic will relate to the experience of the students.

2. LECTURE (alone) - refers to times when the teacher is talking to the class.

   If the lecture accompanies uses of other media, then indicate this on the adding machine tape as, for example, 2-26 which then means that the lecture is being used to explain a wall chart. This dual listing is to be used in only exceptional cases where the lecture would be in explaining the wall chart.

3. MOTIVATIONAL STATEMENTS - refers to explaining what information is important and desirable for the students to know; positive suggestions to the class; attempts to stimulate interest.

4. JOKING - refers to any humorous statements which involve some anecdotal characterization. Does not include merely friendly jesting reminding the class that this is the time for work; this would come under No. 3.

5. NEW MATERIAL - refers to material not studied previously; it may be above and beyond the standard algebra course of study.

6. KNOWN INFORMATION - refers to topics taken up which are already familiar to the students because of other classes they have taken. This requires observing the class activity and making a spot check with a number of students. Sometimes proof of known information can be indicated by the restlessness on the part of the students or by their deciding to work on something besides what is supposedly the main focus of attention during class. No test items should be prepared on the basis of this previously known information.

7. SIMPLE AND KNOWN INFORMATION - refers to such easy material that it would be common knowledge.

8. GROUP DISCUSSION - refers to a free interchange of ideas among the students and the teacher.

9. QUESTIONS TO CLASS - refers to specific questions addressed to the students with them answering individually. This refers to oral questions. See also group tutor device, No. 53.

10. QUESTIONS BY INDIVIDUAL STUDENTS - refers to questions that may come up during a teacher lecture or during a study period. Does not refer to questions which come up during a group discussion or a review.

11. PERSONAL INTEREST - refers to personal experiences of the teacher which are not related to the content.

12. INVOLVEMENT - refers to students doing or making other than listening, writing, studying; e.g. they may be drawing charts, helping individually with a demonstration, writing in small groups on chalk boards or making models.

13. ORAL READING BY STUDENTS - refers to reading from a book to the class orally.

14. TEST REVIEW - refers to going over specific items and information to be covered in a test to be given shortly.

15. REVIEW - refers to going back over points for clarification to the class.

16. INDIVIDUAL STUDY - refers to students working on problems, writing and engaging in the study of textbooks. Make a special notation if the study period is a general one and not devoted specifically to algebra.

17. INTERRUPTIONS - refers to class announcements on the PA system in the middle of the class, visitors coming to talk to the teachers.

18. NOMENCLATURE - refers to teaching vocabulary terms other than formal algebraic definitions.

19. SPELLING - refers to teaching how to spell words properly.

20. TEACHER EXPERIMENTS AND DEMONSTRATIONS - refers to work with demonstration equipment which does not fall in other categories. Do not include chalk-talk in this category.

21. SOUND FILMSTRIPS - records or tapes accompanied by a filmstrip.

22. FILMSTRIPS - 35mm transparencies shown one frame at a time.

23. LOCALLY MADE 10" SLIDES

24. TEACHER-MADE 10" SLIDES

25. RECORDINGS (tape and disk) - any sound recording used as part of class instruction which does not fall under No. 21 (see No. 43).

26. WALL CHARTS - commercially produced or locally made charts and graphs.

27. OBJECTS - tools and other physical objects.

28. SPECIMENS - things from nature such as rocks, animals.

29. MODELS AND MOCK-UPS

30. CHALK WRITING - using the chalkboard to place letter and number symbols.
    a. talking while the writing is placed on the board.
    b. reference to material placed on the board before class began.

31. CHALK DRAWING - drawing of pictures and graphs and other non-letter or number symbolic types of material

32. ROOM MECHANICS - directing students or taking time for moving of desks or other furniture, arranging ventilation and heating, cleaning chalkboard.

33. 2" x 2" SLIDES - 35mm transparencies, mounted singly

34. 3¼ x 4" SLIDES
    a. commercial
    b. locally produced

35. KINESCOPE RECORDINGS - 16mm copies of television programs

36. 16mm FILMS - black & white silent

37. FILMS - black & white sound

38. FILMS - color, sound

39. ENTERTAINMENT FILMS

40. FILM RE-RUN

41. FILM INTRODUCTION

42. FILM HISTORY AND DRAMATIC SEQUENCE

43. FILM STOPPED ON SINGLE FRAME

44. STUDENTS WORKING PROBLEMS ON BOARD

45. REMINDER TO CLASS TO TURN DIALS

46. GROUP TUTOR DEVICE - the use of an overhead projector of any type with questions which are projected on the screen with students writing answers and then checking answers by means of an answer which is subsequently projected by the overhead.

47. WRITING ON ACETATE ON THE OVERHEAD PROJECTOR

48. STUDY SHEET - dittoed questions or statements being used in study.

49. DISCIPLINE

50. SINGLE CAMERA CLOSED-CIRCUIT TELEVISION WITHIN THE ROOM

51. CLOSED CIRCUIT TELEVISION FROM ANOTHER ROOM

52. BROADCAST TELEVISION

53. RADIO PROGRAM ON TAPE

54. FLIP CHART - a pad of newsprint with pages which are turned while the pad is on an easel; or pieces of cardboard which are placed on a stand which are turned as the presentation progresses.

55. FLAT STILL PICTURES - photographs and drawings.

56. OPAQUE PROJECTION - (make a note of type of material which is used on the projector).

57. TEXT AND OTHER BOOK ILLUSTRATIONS

58. MISCELLANEOUS

59. PROGRAMED LECTURE - concise, planned progression and student response.

60. EDITED TAPE

61. COMMERCIALLY MADE 10" SLIDES

62. TEST

63. RECITATION - (usually put under No. 9, however, for most tallies)

64. PROGRAMED MATERIALS

ANALYSIS OF LEARNING PROFILES 1 AND 2

The research study of first year algebra in the ninth grade was begun with the same introduction to the students in both classes to explain their role in indicating learning on the program analyzer. The major part of the information to the students was presented by a motion picture.*

Most significant is the closeness of the two profiles in their heights and variations. This indicated a face validity for the program analyzer ratings in these two classes.

***"Profile Film", Division of Educational Communications, New York State Education Department, 1960. Black and white, 11 minutes.**

ANALYSIS OF LEARNING PROFILES FOR THE STUDY OF FUNDAMENTAL OPERATIONS

The first unit for the Control Group was taught in nine class sessions (Profiles 3, 5, 7, 9, 11, 13, 15, 17, 19). The unit was a review for the students since they had been introduced to algebra in the eighth grade. The learning profiles for the unit were analyzed in light of previous research with the program analyzer. It was determined to present the same unit in five class sessions (Profiles 24, 26, 28, 30, 32) utilizing the efficiencies offered by the new media. In fact, material which took eight days in the Control Group took only four days in the experimental group. Because of the already compressed nature of the unit content and because of its generally verbally symbolic nature as a review, it was difficult to compress the material further with newer media. This was particularly true since it was necessary to prepare materials largely on the verbal symbol level. Unfortunately it was not possible to compare learning by the experimental and control groups on this review of fundamental operations.

ANALYSIS OF LEARNING PROFILES 3 THROUGH 20

During the class shown in Learning Profile Number Four, a unit of information on set theory which was not a regular part of instruction was introduced to the experimental group. The control group (Learning Profile 3) received normal instruction centered around a standard algebra textbook.*

By this arrangement it was planned to delay introduction of the normal class content in the experimental group approximately eleven class days for these reasons, (1) time was needed to prepare an integrated approach to an improved unit based on the learning profiles of the control group; (2) previous research had indicated that the use of the new media made it possible to cover more information in less time, and our research design required that the control group should receive its presentation before the experimental group; and (3) the experimental group would then be able to learn in greater depth during the time left after covering the normal class material.

Since the two groups were not covering the same information it was not possible to compare the specific points of the profiles. However, some general trends can be noted.

The experimental group received its information by means of modification of the Group Tutor Device. A teaching machine program in programed text format** was adapted for group use by the approaches indicated in Table I.

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*Daymond J. Aiken, Kenneth B. Henderson and Robert E. Pingry, Algebra, Book I, McGraw-Hill Book Company, New York, 1957, 434 pp.

**Lewis D. Eigen, Sets, Relations and Functions, Book I, Center for Programed Instruction, New York, 1961, 68 pp. Ibid., Book II, 97 pp. Ibid., Book III, 89 pp.

Profile No.	Procedures for Group Study of Program	Ave. profile rating
4	A. Key symbols, referred to in several frames of the program, were placed on a transparency; hence only 1 transparency per average of six frames was necessary	51%
6	A. Key symbols, referred to in several frames of the program, were placed on a transparency; hence only 1 transparency per average of six frames was necessary	35%
8	B. A typed copy of the program with the answers filled in was projected for the class to read	39%
12	B. A typed copy of the program with the answers filled in was projected for the class to read	24%
8	C. Lecture discussion using programed approach	32%

Table I. Approaches to Presenting Programed Material to Group.

These different approaches to presenting the same program were an attempt to find which would be most effective for later presentations of programed materials. None of the approaches were highly effective as indicated by tests and by profile ratings which did not pass 60% at any time and on the average did not pass 50%. On the basis of this it was planned to attempt two approaches to other content later in the year: (1) groupprograming for the Group Tutor Device which had not been tried in algebra, and (2) individual use of programed materials.

A class session (Experimental Group Profile 10) in which the teacher used a normal approach (which involved discussion of a study assignment, brief lectures averaging two or three minutes, questions guiding class discussion implemented by chalk talk, and assignment of homework) resulted in a much higher average percent of learning (63%) than was true of the other experimental class where the students were receiving the group presentations of programed materials.

Profile 6 indicates the high relative effectiveness of opaque projection within the class. Note the decreases in learning when the projector was stopped (Minutes 14 and 29) and normal instruction resumed.

Since very different content was being covered in the control group (Profiles 3, 5, 7, 11, 13, 15, 17 and 19) than in the experimental group (Profiles 4, 6, 8, 12, 14, 16, 18, 20) no comparisons could be made between these profiles. However comparable information was to be covered in later experimental groups, so the analyses of profiles with comparable information are found further along in the Atlas of Learning Profiles.

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE EXPERIMENTAL AND CONTROL CLASSES

IN A UNIT ON ADDITION AND SUBTRACTION

A comparison was made of the units of instruction covering addition and subtraction. The control group's profiles for this unit are profiles with odd numbers 21 through 41. The experimental group's profiles are even numbered profiles 40 through 58.

The purpose of the study of the two units was to cover the same information in approximately the same amount of time. The primary variable was to be the inclusion of new media where appropriate for improving learning in the experimental group.

For example, the same information was taken up in the control group (Control 21) and in the experimental group (Experimental 40) where improved methods resulted in greater learning. For instance, going over assignment problems by chalk writing on the board (C 21, Minutes 19-24) was improved by a variation of the group tutor device by which a problem was shown on the overhead projector, the students worked out an answer, and then it was checked against the projected correct answer (E 40, Minutes 21-26).

Lecture and chalk writing on subtraction received the same rating of learning in both groups, (C 21, Minutes 25-36 compared to E 40, Minutes 27-32).

A pattern found in these and other profiles was again indicated in two class sessions where the same information was presented in the control group by means of chalk-talk (C 28, Minutes 22-39) and in the experimental group by means of overhead projection of a slide* and grease pencil writing

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***10" x 10" slide, III, i 2 colors, prepared by N.Y.S. Education Department.**

(E 50, 24-39) with only a slight increase in learning in the control group but (1) less time was required in the experimental group and (2) learning was generally less in the class of students which met during the second hour even when the same method was used for the same content (for instance in C 31 the rating on a percentage problem was 46% on the average and in E 52 the rating on the same problem was 39% with the use of chalk writing accompanied by teacher explanations).

Profile 56 provides another example of the lack of difference between writing on the overhead with grease pencil (E 56, 6-22) and writing on the chalkboard.

Different uses of the same equipment caused different profile patterns. For instance, two different uses of the overhead projector were introduced in Profile Number 54. Writing with grease pencil on acetate on the overhead caused a decreasing slope in the learning profile (E 54, 5-24). However this may have been due to the fact that the subject matter content was not new since it had been discussed in class and studied as homework. When an overhead projectual** was introduced, the learning profile started up (E 54, 27-37) and continued up until the textbook assignment was made. The increase cannot be attributed to new content since the slide had been shown two days before.

**Ibid.

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE EXPERIMENTAL AND CONTROL CLASSES IN A UNIT ON MULTIPLICATION AND DIVISION

The learning profiles representing study of this unit in the control group are numbered 43 through 77. The other class began as an experimental group (represented by profiles 66 through 78.) The class which was the control group finished the unit in a regular pattern and then began the next unit as an experimental class when one of the rotations of the class from control to experimental occurred. It was necessary to convert the class which began the unit on multiplication and division as an experimental group into a control group for the last part of the unit for that particular class (profiles 79 through 105).

Because of this, only control profiles 43 through 55 and experimental profiles 66 through 78 were comparable. And because in time the experimental group was meeting several days before the control group, it was not possible to use the program analyzer approach to improving instruction of the unit. Rather some techniques which were considered as possibly effective were introduced.

Media Utilized in the Two Groups

The ranking of instructional procedures according to average profile ratings (as shown in Table II) was only indicative of possible patterns. Rather than compare one group against the other, the most useful interpretation of this table is the ranking within a particular group.

Chalk-talk and grease pencil. However, there is an example of teaching the same information by traditional and new media approaches which reveals that in some individual cases the new media were used effectively for increasing learning.

CONTROL		EXPERIMENTAL	
Description	Rating	Description	Rating
1. Students working problem on board	72	1. Motivation	65
2. Review	65	2. Locally made 10" slides	60
3. Questions by individual students	54	3. Group Tutor Device	56
4. Motivational statements	53	4. Lecture	54
5. Chalk writing	50	5. Questions to class	53
6. Involvement	49	6. Writing on acetate on overhead	53
7. Lecture	46	7. Introduction	51
8. Questions by individual students	46	8. Involvement	51
9. Individual study	41	9. Students working problem on board	49

Table II Rank order of instructional procedures

A 10" overhead transparency with a mask which reveals a line at a time may be compared with a chalk-talk in profiles 45 and 68. In the control group, division of the type represented as $\frac{x^a}{y^b}$ is taught from minute 27 to minute 34. The average reading for this chalk-talk presentation is 45. The same idea (division of monomials) is taught in the experimental class from minute 25 to minute 29, with an average reading of about 75.

Experimental approaches. Because there was not a wide range of media available on the topic of the unit and because the experimental group preceded the control group (obviating the development of improved media on the basis of the study by the program analyzer of the low points of learning in the control group) there was not a large amount of the instruction carried out by experimental procedures.

The ranking of motivation as the first of the procedures in the experimental group reflects a problem facing both groups: the content had been studied during the previous year under the Maryland Plan of introducing algebra to eighth graders. Hence no matter how the material was presented, not a great amount of learning resulted.

Overhead projectuals* did result in substantial learning because they helped to clarify graphically concepts which the students had in a relatively nebulous state in their minds.

Control group approaches. The ranking of working problems on the board as the most effective approach to learning in the control group was due to the same factors which caused the first ranking in the experimental class of motivation. The students were unable to confirm whether they knew the correct procedures on this familiar topic by working the problems on the board. This opportunity for confirmation as well as review thus became high ranking for learning effectiveness.

Recommended Classroom Applications

No strong recommendations for instruction in such a unit as this can be made because of the relatively small amount of data for the subject.

However, one recommendation can be made: when material is being taken up which has been studied during a previous year, and if it is deemed worthwhile to go over this material again, learning will be most effective where

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*Set of 10" transparencies, IV A. - IV J. prepared by New York State Education Department, Division of Educational Communications. 1962. Black on green and amber backgrounds.

students receive clear-cut presentations (as in overhead slides) and confirmation immediately of understanding of the correctness of details of the student's own work (as in working at the chalkboard and in responding to the Group Tutor Device).

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE EXPERIMENTAL AND CONTROL CLASSES IN A UNIT ON FUNCTIONS

Control group learning profiles 105 through 123 and experimental group learning profiles 82 through 108 show the patterns of instruction in a unit of instruction on functions.

Unit objectives. Going on from the skills and ideas developed in previous units, the objectives of this unit were: (1) to discover the nature of function and how to express functions; (2) to use algebraic symbols to express mathematical relationships; (3) to understand the meaning of direct and inverse variation.

The leading means used to carry out these objectives are shown in Table III.

EXPERIMENTAL			**CONTROL**		
	Description	**Rating**		**Description**	**Rating**
1.	**Study**	**52**	**1.**	**Question**	**54**
2.	**Lecture**	**51**		**Study**	**54**
3.	**Questions**	**50**		**Chalk-talk**	**54**
4.	**Overhead-grease pencil**	**49**	**2.**	**Lecture**	**41**
5.	**Chalk-talk**	**39**			

Table III Rank order of instructional procedures

Standard Approaches in the Control Group

Standard procedures provided for no distinctions between three types of communications media, each ranking first on the list. Question to the class, individual study, and chalk-talk received the same average profile ratings.

Lecture was not as effective in the control group (where 56 minutes were devoted to this approach) as it was in the experimental group (where the teacher lectured less--for 33 minutes). Shorter amount of time devoted to lecture in the experimental group made the lectures more concise and to the point.

Learning in the Experimental Group

Profile analysis of the content of the control group was not possible because during the unit the experimental group took up its information before the control group. As a result experience with the control group could not be applied to the experimental group. The unit was presented quickly and to the point in the control group in 18 class sessions whereas the teacher was delaying the experimental group so that the two classes would be closer together at the time they were taking up subject matter content. Hence 26 days were devoted to the unit in the experimental group. Much of this time was spent in study with the experimental group having exactly double the amount of in-class study time as the control group.

There was a very scant supply of media which were available on the subject matter of this unit. In fact, writing on the overhead projector with grease pencil was the primary technique in the experimental group.

On the basis of the study of this unit, it was not possible to make any recommendations for the utilization of media for teaching algebraic functions. A great need exists for a variety of educational materials for this subject.

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE CONTROL AND EXPERIMENTAL CLASSES IN A UNIT ON GRAPHS

The unit on graphical representation of algebraic functions required a different pattern of experimentation because in the process of rotating groups, the information on each particular topic in the unit on graphs was taken up in the experimental group (profiles 106 through 126) prior to the control group (profiles 125 through 137). As a consequence the improvement planned for the experimental classes was based on procedures which had proved to be effective in previous units.

The unit was introduced in the control group by means of a full class session (C 125, Minutes 2-42) involving chalk-talk and lecture with a lower rating of learning than in the experimental group where only 29% of the time taken in the control group was utilized to introduce the unit by means of using the grease pencil on a prepared grid on the overhead (E 106, 30-42). This occurred in spite of the fact that the teacher was trying to speed the control group up to be at the same point as the experimental group when the mid-year examinations were to be given (shortly after the end of the unit on graphs).

New Media and Techniques

How did these results come about? They were based on careful analysis of subject matter and of procedures used in the course until the unit began. Then on the basis of this analysis and experience in applying instructional media and techniques toward the improvement of instruction, plans were developed which produced the following minute-by-minute and class-by-class increases in learning. Not all such examples are cited.

Much greater learning resulted--including a 90% rating of learning--in the experimental class (E 110, Minutes 206) where key concepts such as ordinate and abscissa were defined using a grease pencil on a prepared grid on the overhead; the same information was taken up in the control class by means of chalk-talk and lecture (C 125, Minutes 3-10) with learning reaching a relatively low 50%.

Even the use of such a very simple communications approach as the grease pencil on acetate with grid lines on the overhead resulted in greater learning (E 112, Minutes 19-26) than lecture and writing with chalk on a wall chart with grid lines (C 127, Minutes 29-36).

An educational film* brought a sharp increase in learning in the experimental group (E 122, Minutes 34-44). Only a pertinent section of the film was utilized.

In spite of the fact that it was presented for a review, a filmstrip** developed a high level of learning (E 126, Minutes 3-25). Furthermore this level of learning progressively increased throughout the filmstrip presentation. Learning began to reach a high peak at Minute 22, but the teacher did not believe in practical examples and asked the student projectionist to skip this section. The student advanced quickly through the section, but asked, "Would you like me to go back through that again?" The teacher did not want to do so.

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*"Equations and Graphs of the Parabolas," Modern Sound Learning Aids, 1960, Black and White, 29 min.

**"Plotting Graphs," (Light on Mathematics Series) Jam Handy, 1943, 69 frames, black and white.

With the background afforded by the color filmstrip, the students maintained a high level of learning while using "programed study sheets" (E 126, Minutes 28-44). These sheets had questions and problems from the textbook. The student would work the problem, raise the paper covering the right-hand side of the study sheet, and there find the answer to check his work. If he had made a mistake he would check back over his procedures and consult with the teacher if necessary.

Supplementary Material

Because the experimental group was well ahead of the control group and could not advance beyond a certain point before midyear examinations for all students, they were given some materials to review, a topic studied by them during the previous year under the Maryland Plan: inequalities.

The topic was re-introduced with a filmstrip*** (E 128, Minutes 5-26). The teacher accompanied the filmstrip with a lecture. The next day (E 130, Minute 14) the teacher reminded the class to turn their dials. He indicated that this was their responsibility and it was necessary so we could know their reaction to materials such as the filmstrip# shown the previous class day (E 128). He said, "We need to know, do you like the filmstrip better or less than me standing up here." (An explanation was subsequently made privately to the teacher explaining that the media were being used to assist him in increasing his own effectiveness, not to compare him against the media.)

***"Inequalities", McGraw-Hill, 1961, 20 frames, Modern Algebra Series, Color.

#*Ibid.*

ANALYSIS - GRAPHING INEQUALITIES

The value of a wall chart was indicated by the fact that a chart[##] which had been located on a wall near the door for two days contained the information needed to answer the first part of a quiz. It had been taken down the day before the quiz. Most of the students scored 100 per cent on this section of the quiz. The students had also studied graphing inequalities by overhead projectuals[###] and by programed study sheets. All but two students scored between 75 and 100 per cent on the quiz. The two students had no background with the Maryland Plan as did the rest of the class.

Summary Analysis of Instructional Approaches

Table IV reveals the rankings of various instructional media in the experimental and control classes. The rank was determined by the average profile rating for the unit.

GRAPHS

Experimental	Control
Students write on board	Joking
Film - black & white	Question to class
Local 10" x 10" slide	Students write on board
Chalk-talk	Lecture
Filmstrips	Study
Writing on acetate	Chalk-talk
Question to class	Tests
Lecture	Wall charts (must be chalk graph)
Tests	Review
Room mechanics	
Individual study	
Test review-going over past tests	

Table IV Ranking of instructional media and techniques with those with highest learning profile ratings at the top.

[##] "Symbols for Inequalities," New York State Education Dept., Division of Educational Communications, 1962, Chart 22" x 28", cardboard with 2¼" symbols, black and white.

[###] "Inequalities" same source, 10" x 10" slides, Nos. VI A, B, C, D, multicolored overlays.

Whereas individual study had ranked first in the unit on functions, it ranked last on this unit on graphs which lent itself well to various forms of graphical representation by communications media. Although another form of student participation was ranked first (students writing on chalkboard), motion picture film, overhead projectuals and filmstrips resulted in relatively high levels of learning.

With joking and questions to the class ranking first in the control group, there was evidence (in addition to that cited in previous parts of the chapter) that the teacher felt more at ease with his normal procedures. Consequently, a better state of rapport existed. This is also indicated by the relative height of lecture in the class.

This ranking indicates that one must carefully select an instructional medium for each particular topic. Whereas one might be highly effective for certain topics, another might be highly effective in another. One exception to this is the instructional motion picture. Until the film shown in this unit was presented, no film had been directly pertinent for use. Possibly if more films planned for use in the algebra classroom were available, films might have proved equally effective in other units. Should this possibility prove to be true, it would again support the principle that it is essential to study the communications media in detail to determine which are to be utilized and how they are to be employed.

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE CONTROL AND EXPERIMENTAL CLASSES IN A UNIT ON SYSTEMS OF LINEAR EQUATIONS WITH TWO VARIABLES

The major objective for this unit was to develop knowledge of how to solve a system of two linear equations with two variables. There was some concern also for improving student ability to use variables in writing equations for solving verbal problems. In the Atlas the profiles are labeled, "Unit VII, Simultaneous Linear Equations." The control group is represented in the odd-numbered profiles 139 through 159; and the experimental group is represented by even-numbered profiles 140 through 160.

With communications media introduced in this unit, an attempt was made to study the control profile each day and to increase learning in the experimental class (which took up corresponding subject matter) through use of various communications media and techniques including programed materials, objects, charts, overhead projectuals, writing with grease pencil on the overhead, and other instructional patterns.

A word problem was presented in the control group by chalk-talk (C 155, Minute 38-44) and in the experimental group by an overhead projectual* (E 156, Minute 34-37). The result was (1) higher rating of learning in the experimental group--50 percent compared to 48 percent; and (2) one-half as much time required to communicate the same information--experimental group only 3 minutes compared to 6 minutes for the control group.

(1) Overhead projectuals. Some overhead slides were locally produced to increase learning. For instance, in the control group (C 139) solving equations by addition took four minutes for a chalk-talk presentation and

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*"Fruit Dealer" VIIC, 10" x 10" slide, New York State Education Department, Division of Educational Communications, 3 overlays, 3 colors, 1962.

yielded a rating of learning of only 48 per cent for four minutes. An overhead slide** was introduced to present this same topic in the experimental group (E 140) in only 3½ minutes and the learning rating was 55 percent.

Analysis of chalk-talk in the unit revealed a very close rating in the classes: 52 percent (for 51 minutes) in the experimental group was compared to 51 percent, (for a total of 117.5 minutes) in the control group. More time was devoted to chalk-talk in the control group because it was replaced by other media in the experimental group in many cases.

(2) Grease pencil on the overhead. Writing with a grease pencil on the overhead was a technique which replaced some of the chalk-talk. This proved to be slightly less effective in this particular unit--and with a teacher more familiar with communicating with chalk in contrast to grease pencil. The average ratings for the unit were not greatly different, however; 50 percent for the experimental group using grease pencil (for 43 minutes) compared to 51 percent for the control group using chalk (for 117.5 minutes). In some cases, the profile rating of learning was lower in the experimental group due to a manner of use of the program analyzer in the class. This was corrected by the end of the unit (Profiles 159 and 160, Minute 5) by instructions given to both groups to insure that the base level of rating was at an average setting before the class began to make its rating of learning. In interpreting the profiles for the part of the unit where the experimental group did not begin with this equating

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**"x + y = 6", 10" x 10" reveal slide, New York State Education Department, Division of Educational Communications, 1962.

process, labeled "testing analyzer" on the profiles, an increase of ten per cent would give an approximate rating which would be actually more accurate than those which are shown. However the relative change from one type of media to another provides another basis for interpretation.

(3) Wall chart. Use of grease pencil on the overhead for routine review and to show a problem from the text did not have as much effect upon learning as the introduction of a wall chart*** which described "Word Problem" on weight of a man and his son. (E 154, Minutes 17-22).

(4) Programed materials. A small pilot trial of programed materials# for individual use was initiated during a regular study period (E 144). Programs were given to four students. A machine was used in class this day; the students took only the program home and used them. Student reactions were favorable to this method of study and it was determined to introduce programed materials in later units (see Unit VIII on Special Products and Factoring and Unit XI on Radicals and Exponents).

(5) Object. Reference to an object--the classroom clock--resulted in a very slight increase in learning in the control group (C 153, Minute 26). The slight amount of the increase may have been due to these factors: (1) the concept was fairly difficult and many students were not able to grasp it; (2) the students saw that this was an impromptu side-light added to clarify a point to an individual student, and even though he presented valid new

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***"Word Problem" New York State Education Department, Division of Educational Communications, 1962, Chart 22" x 28", Cardboard with 2½" symbols, multicolored.

#Teaching Materials Corp., "Simultaneous Equations" Unit 11 of Fundamentals of Algebra, Part II, Grolier, 1961, 338 frames.

information the students realized this was something which they would not need to know to pass the course.

Test results. As might be anticipated by the small range of difference between experimental and control learning profiles, unit test results revealed no great differences between the control group with an average test score of 80 percent and the experimental group with one of 77 percent.

However the profiles did indicate that perhaps on some of the details covered in the test, the control group had more exposure than the experimental group. Whereas the control group profile dropped during the test (C 159, Minute 23-38), the experimental group gave strong indications of learning during the test (E 160 particularly Minutes 16 and 25-34). The fact that the unusual facet of profile peaks during a test occurred indicated that as they went through the test, the experimental group was learning new information, whereas this did not occur at all in the control group.

Recommended procedures. Although the new media and techniques described in this chapter would prove valuable for experimentation in other situations, there were no outstanding advantages proved for the experimental group--or for that matter--for the control group. There are several reasons for this: (1) The particular topic is very mechanical in content as taken up in this class; (2) the subject matter was covered on a very verbal level and so few applications were studied that the unit was abstract to the learners; (3) perhaps unconsciously the teacher was favoring the control group by (a) providing more in-class study time for the experimental classes (63 minutes compared to 47) and thus forcing more study time at home upon the control students, thus giving them a greater total amount of study time; and

(b) covering more completely in the control group the specific items of information to be covered in the unit test.

ANALYSIS OF LEARNING PROFILES
OF A UNIT ON SPECIAL PRODUCTS AND FACTORING

Profiles 161 through 198 review the study by the two classes of a unit on "Special Products and Factoring."

Purpose. The specific purpose of this unit was to evaluate the effectiveness of learning in an instructional unit centered in programed materials studied individually in conjunction with special grouping procedures.

The study provided a means of meeting a need for exploring approaches to adapting utilization of programed materials into a typical school setting.

Procedures. The classroom teacher, the project's audio-visual specialist, and the programed instruction specialist of the New York State Education Department pre-planned the entire unit. The plans were based upon a general interpretation of previous learning profiles rather than the specific day-by-day analysis of learning profiles and the consequent building of instructional materials and techniques which characterized the other units of this study. In general, profiles had indicated that learning was high during individual study. In general, presentation of material by the group tutor device had proved effective. A combination of these procedures was planned.

Careful study by the teacher and curriculum specialists indicated that a portion of one teaching machine program* would best fit into the curriculum of the particular school in which the study was conducted.

***Daniel P. Murphy, "Special Products and Factoring," Chapter 11 of Algebra I. (Temac Programed Learning Materials, Encyclopedia Britannica Films, 1961), pp. 569-673.**

The control group was instructed by regular procedures centering in the textbook with lecture-discussions followed by individual work on assignments in the textbook. Class discussions often involved chalk-talk.

A pre-test indicated an average of 28 percent for the control and experimental classes. It indicated that the material was worth the time required to study it.

The experimental group was engaged in the procedures indicated by the following sections: orientation, initial grouping, grouping and testing, preparation for achievement test (test results are reviewed at the end of the chapter), secondary grouping and review.

(1) Orientation. (Profile E 164) The teacher introduced the subject matter content of the unit by lecture and chalk-talk relating it to previous units.

The programed materials were introduced, after materials had been passed out, by lecturing from a statement prepared in cooperation with the programed instruction specialist and the audio-visual specialist. Principles of programed instruction were explained. Detailed directions were made for the use of the programed materials and answer sheets. Students were given a certain number of frames to complete as homework each day; however a limit of 40 minutes in time was all that students could be required to spend due to school policy. Although it was not in the original plan, the teacher told the students that they were not to work on more than the assigned frames.

(2) Initial grouping. When the experimental class (Profile E 166) met, it was divided into two groups. Group X consisted of students who had completed the first assignment. Group Y were those who had not completed it.

The teacher spent part of the period with one group and part with the other. The plan was for the teacher to provide special small group instruction to each group, with the groups moving into circles. However the students were left in rows; the teacher lectured in his usual fashion to each group on the same topic; and some students were observed looking from their own study group to the one which was receiving a lecture.

(3) Grouping and testing. In the next class day (Profile 168) the same pattern of grouping was followed as a basis for providing a test situation. While a test was given to check comprehension, students who had been absent were given instruction in the use of the Temacs. Under each test paper was a carbon and another copy of the test so that when the students turned in their original tests they still had a carbon copy. They were then given dittoed answer sheets by which they could immediately check their answers. Although it was planned that it should be explained that each student should use the test results as a basis for planning his study of the programed material, this was not done.

Because of a flu epedemic, too many students were absent to continue with the regular class program (in this case the programed materials), so an optional topic was presented. And the teacher gave the experimental class a disadvantage by taking their programed materials from them. The textbooks were not taken from the control class. Hence by this independent action of the teacher the experimental students did not have a good period of time in which they could use the programed materials for individual study. His attitude was expressed in the statement that, "some of you might go ahead and I don't want that."

At the various times in the unit where the teacher was to give small group instruction, his pattern was to face the group of students who were in a row or two and make the same type of presentation as he would to the whole group. Since, contrary to prior planning, the teacher left the students in rows, other students in the class were facing him and were consequently led to listen to him in the usual class pattern. The suggestions for work with individuals in small groups given at the end of this chapter under the heading "(3) Individual teaching," were not followed. The attitude of the teacher was expressed in one class (C 175, 10-13) where he stated, "I am not a babysitter who would chase you and make you study." However he added, to the control group only, "but I am available and I won't tell you to come in." In this discussion he indicated a limitation of the teacher in comparison with programed materials by stating "I don't have time to go over each problem and show you how to correct yourself."

(4) Preparation for achievement test. Although the plan (for E 172) developed for a class to prepare for an achievement test by the teacher and the research staff included provision for grouping the class on the basis of a previous test (E 168) into two groups so that instruction could be adapted to the different levels of comprehension of the two groups, this was not carried out by the teacher. Rather the teacher resorted to the usual pattern of lecture-discussion-chalk-talk.

The test was given in C 173 and E 174. The students kept a carbon copy of the test and turned in the original. Then they were given duplicated sheets with answers by which they could check their test results. Some items missed by a large number of students were discussed by the group. Since better students did not miss these items, their time was wasted during this period in comparison to how it might have been used when they would have been separated into a separate group able to work on the programed materials and to go over key test parts as appropriate.

(5) Secondary grouping. (Profile E 176) When the experimental class met, it was divided into three groups based on levels of achievement on prior tests. As planned the teacher worked with each of the three groups separately. Groups with which he was not meeting worked on the programed materials. However at one point the teacher called for the attention of the whole class to discuss the facet of the assignment.

The high group consisted of six students (including one student who had done average work to this point in other units of instruction), a middle group of ten students, and the low group of seven students including some students who were absent for the test (and a student who regularly had A grades in the class). With the low group the teacher used a pattern of censoring the students for just going through the mechanics of answering the program and not learning and then lectured with chalk on factoring and products. However in the average group, he began with the elementary concept of understanding squares as a basis for more advanced concepts.

This same grouping pattern was followed on the next class day (E 178). The students apparently felt that this was a most worthwhile means of learning, and they made a strong indication of a decrease in learning when the class was interrupted by an announcement over the public address system that an astronaut had been launched into orbit around the Earth (E 178, 40-45).

The pattern was essentially repeated the next day (E 180) although the plan was changed so that after the discussion from the start with the high group alone, he gave them a quiz. This same pattern was followed with the other groups, except both the middle and low groups took the quiz at the same time.

The pattern was not followed the next day with the teacher reverting to his regular pattern of presentation (E 182); teacher lectured to all students rather than to groups as planned. He used chalk-writing rather than grease pencil. In other words, he did not follow the plan which he had helped to devise. However the next two days (E 184 and 186) the plan was followed fairly well although the teacher felt that only two groups were needed--the small high group as one and the average and low students in the other. This further indicated that the teacher was not familiar with procedures and advantages of small group instruction.

Yet another indication of the same lack of familiarity was shown the next day (E 188) when rather than following the plan whereby the high group was to receive enrichment materials during part of the class and the teacher was to work with the other groups, the whole class was given the period to do their homework in the programed materials.

In spite of this situation, students themselves, since they were grouped according to ability in the unit, found ways to gain by the experience. They found much value in consulting with fellow students on a similar level of achievement working in about the same part of the programed materials. There was some stimulation due to the dynamic characteristics of small groups in and of themselves which resulted in possibly more concrete and lasting learning although this could not be identified in the highly verbal examinations which were administered.

(6) Review. The class came together for review (E 190) through group discussion directed by teacher questions. The plan was for the teacher to give individual help to students. This was done during a period of individual study toward the end of the class. Additional review as provided, for both control and experimental classes on the next day (E 292) when the students were given a "programed study sheet" which gave questions, answers, and numbers of frames in the program to which the student could refer in case he had trouble with a particular problem.

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Rate of progress. The students progressed much more slowly than the teacher had anticipated in the control class where normal procedures were followed. In order to keep the groups together (and because the teacher gave the students the opportunity to agree with him that the assignments in the programed instructional materials were too long), the teacher cut the number of frames assigned per night in half. Hence it can be assumed that had the experimental group been allowed to continue at the pace originally anticipated as possible by the teacher--and which the students indicated they could follow--they would have been able to complete the unit in approximately half the time that it took the control group to complete it.

Response correctness rate. As the students wrote their responses to the program, they kept a record of their errors. A tally of this record indicated that on the average students responded correctly to 97.5% of the program frames. Since their test scores indicated considerably lower percentages, the students apparently were going through the program without adequate follow-up to build up recall.

Additional time on unit required of control group. Perhaps with the realization that students were able to progress more rapidly with programed materials, the teacher devoted his full efforts to classroom instruction through chalk-talk and class discussions through most of the entire class periods. He then gave assignments of homework in the textbook which required the students to spend forty minutes on homework at night. Thus in the entire unit, he allowed only 39 minutes to the control group for individual study of the homework assignments in class. Thus the control group spent at least 308 more minutes in homework studies. Since junior high school students seldom if ever study more than they are required, it can be seen that the control group spent much more time on the unit.

This pattern existed in other units, but not to the degree that it occurred in this particular unit. By the middle of the year, the control group had spent 159 minutes in individual study in the classroom whereas the experimental group had spent 379 minutes in individual study.

Evaluations of programed instruction by persons involved. As might be expected, each of the persons involved in the utilization of the programed materials evaluated them from a different perspective. Following are evaluations by the teacher, programed instruction specialist, researcher, and, most important, the students themselves.

(1) Programed instruction in the eyes of the teacher. The teacher indicated that one unit was not long enough to make final judgments on the merits of programed instruction in algebra. He indicated that the average students were the most favorably impressed with the materials, but that they did not assess their abilities in relation to the materials accurately. He felt that the average and better students learned less through programed instruction than in a regularly organized class. However he felt that weaker students reach approximately the same level of learning as they usually reach in less time.

Some of the teacher's actions revealed an attitude of dislike of this medium of instruction. For instance, one day he told the students to "get that garbage off your desks" (referring to the programed materials) and then proceeded to make a presentation in his normal pattern of group study of the materials.

(2) The unit presentation as seen by a programed instruction specialist. The New York State Education Department Assistant in Educational Communications who specialized in programed instruction saw in the unit presentation some key aspects of the role of programed materials in the classroom situation. He noted that the progress of the students clearly indicated that media cannot themselves teach; a person sensitive to the needs, interests, abilities, backgrounds, and personalities of the students in the particular class is needed, but that person must also be familiar with a wide range of ways of utilizing programed materials. He felt that the plan for the unit could be more fully developed and used as a basis for studies in other school situations after teachers had been trained in the various types of grouping procedures and individual guidance needed for fully effective use of the programed materials.

On the basis of observation and responses to a questionnaire given after the unit was completed, he concluded that the students needed to be weened away from the current program. Since it is highly structured, the students need to have a very unstructured teaching activity along with the program. In spite of teacher reluctance to adapt to small group instruction, patterns of student behavior indicated that flexible grouping can be done within the boundaries of a standard classroom. He indicated that students could be trained for small group instruction.

(3) The unit as viewed by the researcher. The observations of the researcher are indicatedin the various other parts of this chapter. However, his own general opinion of the utilization of programed materials in the unit was that the plan for the unit was not followed sufficiently in class to give the programed materials a fair trial. Reasons for this included: (1) the relatively small amount of use possible for use of the program analyzer as the basis for improving instruction (2) the teacher was not adequately skilled in small group instruction and leading students to progress at different rates in view of their backgrounds; (3) an influenza epidemic broke up the continuity of the unit; and (4) when students in the control group learned how well their friends in the experimental group were doing with programed materials, they worked much harder with their textbooks to the point where they were able to achieve as effectively.

The possibilities for learning in this unit and the self-generated interests on the part of the students when able to work in small groups give rise to the question of whether or not more research is needed to re-test such grouping plans as the Winnetka Plan with the opportunities which new media, including programed instruction, offer for implementing such plans.

(4) The unit as evaluated by the learners. The reactions of the students who worked with the programed materials day after day through the entire unit were obtained by an anonymous questionnaire filled out after the unit was completed. The following information was taken from the questionnaire: The programed instructional materials provided enough practice in the topic, factoring. The assignments were neither too easy nor difficult. Partly influenced by teacher statements, the students indicated that the assignments (number of frames per night) were a little too long until reduced toward the middle of the unit. They liked homework in the programed text better than in the regular text. The assignments helped a great deal to learn about factoring.

The students liked breaking into groups for classwork. They indicated that they liked working with a group at their own ability level, the greater opportunity for special teacher attention, and more chances for individuals to gain guidance in solving problems. The students liked to work with others on homework assignments some of the time, but not all of the time. Students felt they learned more in small groups than they did in the class as a whole or individually.

In looking back on the unit in the experimental group, the students learned more about factoring from the programed text than they did from classroom instruction. However part of the class indicated that they learned some things in class which were not in the programed materials.

The same number of questions were asked in class during this unit in the view of 12 students; 9 felt they asked fewer; 4 indicated more were asked. Apparently the patterns of individuals changed. It should be noted that as a rule, the students did not ask a large number of questions in this or other units. In fact "questions by students," one of the categories under which data were collected took only a total of 40 minutes out of the total of 3307.5 minutes during which the class met from the beginning of the school year until the end of the first semester.

On the average, students liked this unit better than the previous units in which they had not as a group had individual programed materials. Comments were that the material and the unit were easier to understand, more interesting, and more fun; and they indicated, however, that regardless of the approach algebra is still algebra.

Recommended classroom applications. Based on the experimental approaches developed by delving into the utilization of programed instructional materials in a regular unit of instruction with an average group of students and a typical public high school, the research staff gained by observation and learning profile analysis some ideas which can be useful to teachers seeking to improve instruction through new media.

(1) Format for programed instruction. A programed textbook which can be carried by the student to class, to study period and to his home is convenient for him and leads to greater opportunities for adapting the use of the programed material to his normal study patterns. When students were asked their opinion of the programed text in relationship to the regular textbook, most of them responded that they preferred programed text. They also indicated that they liked this method of study.

(2) Grouping procedures. Within a regular classroom it is possible to assign students to several small groups in which they can work with students of comparable ability. Students indicated that they like such arrangements. The basis for grouping of students can be prior achievement, achievement in the particular unit of instruction, and ability to advance within the particular group. Even in moving from a very small class situation into grouping activities, students will be found to work productively in small groups. The group dynamics of each situation make it possible for small group discipline to develop. Students are able to communicate with each other to serve as teacher and learner and to work over difficult points which other forms of classroom organization would make impossible in view of time. The patterns which develop in grouping can also carry forward into other class activities to the benefit of student learning. For example in work on the chalk board after a grouping experience a student would often receive encouragement and occasionally appropriate suggestions for improvement from his classmate. In other words by introducing grouping procedures into the class it is possible to develop a sense of group understanding that there are many possibilities for learning in groups.

(3) Individual teaching. As students are working individually in class on their programs, in groups divided according to ability, the teacher can analyze personalities and abilities to determine which could benefit by working with another student--with mutual increase in learning. One basis for determining the type of individual assistance is by test results and/or frame number in the program.

In working with individuals in small groups, the abler students will benefit most by a program with fewer steps, use of the discovery approach, encouraging alternative approaches to working out equations and problems, and discovering applications. Less able students need first careful analysis of the basic problem facing each individual followed by step-by-step procedures, carefully planned motivation, experience in framing his own problems, suggesting applications, and allowing student clarification of the processes through their own work and explanations with the teacher serving as reflector for student to understand his process. The very least able students need a similar approach but based on a tutorial, out-of-class session to find many more approaches for individual help.

(4) Other new media used in relation to programed material. As students work individually on programs or in small groups, frequently a pattern of significance to the whole group is revealed and the teacher can utilize a grease pencil on the overhead projector to clarify points or he can make prepared overhead projectuals to recall key concepts or to introduce new ones which gave an overall picture not possible in the other patterns of instruction in the unit.

One of the key problems in introducing programed material is to give a student adequate motivation to feel that it would be worthwhile to devote his time individually to reading the program, making responses, checking responses, and studying class techniques. Motion pictures can offer help to provide this motivation.

In a group which is not familiar with programed instruction it is possible to introduce by reproduction a page of a typical program on the overhead projector so students can see the type of questions and how a response is supposed to be made. In our particular unit and situation, the students had become familiar with programing through the group tutor device. But to familiarize them with the format of the programed material they were to study including a plastic slide which revealed answers, the opaque projector was used with the advantage that an actual program could be shown in its plastic folder.

(5) Role of the teacher. As with the introduction of any new type of instructional procedure, the teacher needs to re-evaluate his particular role in the class so that he can adapt to such procedures as individual study and small group instruction. It is also important to communicate sincerely to a student that he feels that this type of material is going to benefit them and they will be able to learn effectively through it. No matter how good an instructional material may be, whether it be programed instruction or a book, it cannot positively affect the learning of individual students unless they feel that it is something that will be worth their while.

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE EXPERIMENTAL AND CONTROL CLASSES IN A UNIT ON FRACTIONS

The subject matter of concern in this unit was algebraic fractions, equivalent fractions, "reducing" fractions, multiplication and division, addition and subtraction with different types of denominators, and changing the sign of a fraction. The control group was instructed by normal procedures (Profiles 201 through 217) and the experimental group received the same subject matter with introduction of new media and techniques to study effects upon learning.

Group programed materials. A major approach to improving instruction in this unit was through the group tutor device. Whereas in the control group the unit was introduced (Control 199) by chalk-talk with some questions directed to the students, a group tutor device presentation based on the teacher's plans for the control group was used as an introduction in the experimental group (Experimental 202). The group tutor device was made by printing and/or typing on yellow cellophane in 3½ x 4" pieces* which were attached end to end in a strip which was projected on a 3½ x 4" aperture overhead projector. The question or statement would first appear on the 70 by 70 inch screen; then students would respond; and then the strip would be advanced until both the question and answer appeared for the students to check the work. The teacher interjected chalk-talk and lecture explanations. No advantage was shown in the profile for the experimental approach, although some difficulty with the program analyzer on this particular day may have covered up some of the difference.

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*"Fractions" New York State Education Department, Division of Educational Communications, 1962. Yellow cellophane. 62 frames (3½ x 4") used a few frames at a time different days in the experimental group.

There is evidence that the teacher was not offering the experimental group as extensive or as good teaching as was offered the control group. A main form of presentation was chalk writing in the control group with an average profile rating of 57% for 221.6 minutes for the unit. The comparable types of presentation in the experimental group are shown in Table V.

Procedures in experimental group	Minutes	Profile rating
group tutor device	92	45.6%
grease pencil	63	49
chalk writing	17.9	49.1
	172.9 min. total	47.9% average

Table V

Table V indicates clearly that profile ratings were lower for both experimental procedures (group tutor device and grease pencil) and for normal procedures used in the experimental class (chalk writing). Thus these types of instruction depending primarily upon the teacher were not of as good quality in the experimental class as comparable to the teacher-centered types of instruction in the control class.

And the teacher gave less of his time for this type of instruction to the experimental class (172.9 minutes) than he did in the control class (221.6 minutes).

Ratings in the entire Control 201 learning profile were higher than those in the corresponding Experimental 204 learning profile. The difference in favor of the control group was reduced in later experimental classes by projecting the group tutor device material on a quarter of the screen thus leaving the rest of the screen for projection of grease pencil explanation to accompany the programed presentation (for instance see Experimental 206, Minutes 22-26).

Programed materials. Programed materials in textbook and teaching machine format were made available to the experimental group students in the library. They were able to check out these materials for use during study periods just as reserve books. With no specific assignments but only a general indication that these materials were available, the students did not use these materials.

Students working at chalkboard. A procedure which resulted in a high amount of student interest was the doing of problems on the chalk-board. Subjective observation of both classes when they were involved in this type of activity revealed: (1) a high degree of student interest; (2) great concern for accuracy; (3) positive, worthwhile exchange of ideas with much teaching by one student with another (resulting in a hum of labor); and (4) the opportunity for individual help of students at the board and at their desks by the teacher.

Because this was an effective activity in the control group (Control 207) it was repeated in the experimental group (Experimental 210). The lower profile in the experimental group may have been due to the following reasons: (1) a higher percentage of the experimental class were at the board so that they could not turn their dials; and (2) the teacher did not allow use of the overhead for part of the student board work although this had been planned.

Grease pencil on overhead. Explanations were often made in the experimental group with the aid of a grease pencil writing on clear acetate on the overhead projector. Since the teacher was more accustomed to use of the chalkboard, he occasionally reverted to the chalkboard. This resulted in the decreases in learning as for instance in the experimental group where he moved from grease pencil on the overhead (Experimental 216, Minutes 8-10) to chalk-talk (where learning decreased Minutes 11-25) and back to the overhead where learning again increased (Experimental 216, Minutes 26-35) until an assignment was given and lecture was used (Experimental 216, Minutes 35-39) when learning dropped. The drop was so great that a brief use of the overhead (Experimental 216, Minutes 40-42) had no effect upon the profile.

Recommended classroom procedures. There are subjective reasons to believe that in another class situation the experimental procedures could prove to be highly effective.

(1) Grease pencil on the overhead. For many explanations in a topic such as fractions, the illustration of points by the use of grease pencil on clear acetate on the overhead is highly effective because of the clarity of the projected image.

(2) Group tutor device. The use of the group tutor device is a convenient way to provide a core of material which can be used to develop group responses and understandings. By projecting statements or questions, allowing students time to write or make a response, and then projecting the answer along with the original question, students become alert and involved in the classroom procedures.

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE EXPERIMENTAL AND CONTROL CLASSES IN A UNIT ON EQUATIONS AND PROBLEMS

Control group learning profiles 221 through 247 formed the basis upon which the unit on "Equations and Problems" was presented to the experimental group in learning profiles 224 and 250.

Unit objectives. The basic unit objectives were to improve skills in solving equations of different types and to increase ability to solve word problems. Emphasis was placed on the mechanics of the equations themselves in the control group. (More information on instructional content is found in the section of this chapter labeled "Special Factors Influencing Learning in the Unit.")

Communications media in the unit. The media selected to seek improvement of instruction included programed and overhead materials and a film.

(1) Overhead projectuals. Several approaches to overhead projection were found to be the most appropriate of available means of approaching the subject matter presentations.

(a) Review. Review of homework, even though by overhead slides* (Experimental 246) was low in the experimental group because it was review and because the class indicated as a group by raised hands (Experimental 246, 31) that these were very simple. The very clarity of the slides helped to make them sense how clear the content was.

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*"Swimming Pool", 10" x 10" slide X28, prepared by N.Y.S. Education Department, Division of Educational Communications, 1962. 3 colors.

"Tractor", 10" slide X29, (same source), 1962. Multicolored.

"Painting", 10" slide X30, (same source), 1962. Multicolored.

"Airplane", 10" slide X31, (same source), 1962. Multicolored.

Learning increased rapidly with masterful presentation of an overlay[**] (Experimental 246, 33½-38½) where after the teacher presented the first stage he showed only part of the overlay and revealed the rest leading the students in a discovery approach. The same procedure was used with the next overlay.[***]

Analysis reveals that although the same amount of time was allotted in both groups (Control 243, 20-41 and Experimental 246, 22-43), the experimental group was able to cover more problems than the control group because of the time saved presenting the problem quickly and clearly in concrete visual form.

(b) Improper projectual use. An advantage of the pre-class preparation of an overhead slide was missed by teacher change of plans. In the control group a long time was taken to draw out a definition of "investment" (Control 233, 27-34). It was planned to merely show a slide[#] showing investment so that the class could go directly into the problem. However, the long discussion approach was again used (Experimental 236, 32). Further time was taken by reiteration of the slide content.

(c) Group tutor device. On the basis of control group profiles (for instance profile Control 221), the Audio-Visual Specialist programed the teacher's chalk-talk presentation and put it in ink on acetate[##] for the

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[**] "Barrels", 10" slide X32, prepared by N.Y.S. Education Department, Division of Educational Communications, 1962, 2 colors.

[***] "Alcohol & Water", 10" slide X32, (same source), 1962, 2 colors.

[#] "Investment", 10" slide X14, (same source), 1962, 3 colors.

[##] "   ," 10" slide XI, (same source), 1962.

10" overhead projector. It was then presented in the form of the Group Tutor Device with the teacher revealing the problems step by step. Learning reached a high peak (E 224, 37) at the point where a slide moved into a culmination.[###] This was left on the screen for the students to refer to during a short study period. The study period was shorter in the experimental group. As part of the Group Tutor Device presentation, a prepared slide[&] was shown. Learning was at a high point during this slide (E 224, 24).

(d) Polarization. More time was required in the experimental group (E 228 as compared to the control group, C 225) to present a slide [&&] than was necessary because the teacher took time to (1) play with the polarizing filter, and (2) explain the nature of polarization. This unpreplanned activity could have led to an algebraic insight if had been carried to the point of showing how the principle could be expressed algebraically.

Light was so much reduced by the filter that the students complained that they could not see well. It was then taken off.

(2) Locally produced film. The part of the unit directly involved with problems was introduced by student involvement in the control group. They wrote on the chalk board and answered orally (C 231, 8-41) with more learning

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[###] Linear Equations, 10" slide x2, prepared by N.Y.S. Education Department, Division of Educational Communications, 1962.

[&] "Number Relationships", 10" slide XB, prepared by NYS Education Department, Division of Educational Communications, 1962.

[&&] "Second Degree Equations", 10" slide XN, (same source), 1962.

than in the experimental group where a film[&&&], locally produced, was used (E 234, 2-13). However, within the experimental group learning increased when the film was stopped on single frame (E 234, 6) and the students became involved in solving problems shown in the film.

The film was of poor technical quality, with some parts not sharply in focus. Use of the grease pencil on the overhead resulted in greater learning during presentation of another verbal problem (E 234, 24-29).

Acceleration trial. An attempt was made to take the presentation on control group 241, program it, and present it at a paced rate in order to allow some time in the experimental group (E 244) for study with teacher help. And it was true that the parallel visual presentation by slides['] in and of itself resulted in a savings in time (31 minutes as compared to 37½ minutes in the control group). However the plan was to pace this presentation to fall within 29½ minutes.

The total result for the experimental group was to save time for individual study. However this was not accomplished because the teacher took class time for (1) working out a problem which had not been worked out

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[&&&] "Equations and Problems", New York State Education Department, Division of Educational Communications, 6 min., black and white.

['] "Wind Velocity", 10" slide X20 prepared by N.Y.S. Education Department, Division of Educational Communications, 1962.
"Wind Velocity", 10" slide X21, (same source), 1962.
"Wind Velocity", 10" slide X22, (same source), 1962.
"Boat", 10" slide X25, (same source), 1962.
"Rate of Work 10" slide X25, (same source) 1962.
"Tank Drainage", 10" slide X26, (same source) 1962.
"Job Completion," 10" slide X27, (same source) 1962.

in the control group (E 244, 38½); and (2) telling a "princess" story. In the latter case, the teacher had asked the class a question. Most of the students raised their hands indicating they knew the answer. The teacher called on one individual who had not raised his hand. When the student was not able to respond, the teacher sat down upon a desk, looked at the class, and began to tell a story. Through this elaborate procedure he went on to make the explanation of the answer--essentially to the one student (E 244, 35½-37½).

Time saved by new media. An example of time saved by using overhead slides[··] for homework was revealed in an experimental class (E 248, 41-46) where the teacher was able to add five minutes of information (as compared to C 245) by using grease pencil on the overhead to provide additional depth information on equations. At the beginning of the class, extra time was needed to arrange for getting programed study sheets to absent students. However these sheets saved time in the overall class because the teacher did not need to read answers to the class as he had in the control class.

Special factors influencing learning in the experimental group. In interpreting the test and profile results of this unit, it is helpful to consider some factors as follows:

[··] "Mixture Problem, Copper and Zinc Alloy", 10" slide X34, prepared by N.Y.S. Education Department, Division of ducational Communications, 1962, 3 colors.

"Chemistry Experiment", 10" slide X35, (same source), 1962, 3 colors.

"Water and Acid", 10" slide X36, (same source), 1962, 2 colors.

"Pharmacist", 10" slide X37, (same source) 1962, 4 colors.

(1) Emphasis on mechanics of equations rather than solutions of problems. In spite of a major portion of this unit centering on the study of word problems (since the textbook was the center of the curriculum), the teacher stressed the mechanics of forming equations for the purpose of developing equations good in themselves. Even though he was working with actual word problems, students were told in a large number of cases to figure out the equation without going on to work out the equation to find the actual solution to the problem. Hence the concreteness of learning possible with the new media in such a unit was minimized.

(2) Learning from other persons. During discussion of the problem (E 238) in the textbook which the class had not completed, one student indicated that a friend (in another class) had worked out the problem and then the student indicated the solution. This was evidence that students had another outside source of learning besides their textbook. They also studied algebra with able friends. Learning from outside sources had a tendency to dilute differences between the classes.

(3) Student homework. Individual interviews revealed that there was consistently more homework in algebra than in other subjects being taught. Every night there was an algebra assignment. This fact explains the small amount of difference between the two classes. The students gained much of their algebra knowledge while studying at home. Since it was very obvious to control class students in the same building wing that visual aids were being used in the experimental group, the students in the control group were stimulated by a sense of competition to put more time in on text study in compensation.

(4) Instructional content. In 8 out of 9 cases where exactly the same information was presented in both control and experimental classes, the ratings of learning were within 4 percent of each other (Table VI). Possible conclusions which we might draw from this are:

(a) Since the content was more review than new material, the particular approach utilized did not matter. The unit subject matter was "old stuff" to the students and the approach was more like a review than seeing the content applied in new situations.

(b) The content should not be held as a rigid constant in future media studies. A basic feature of the new media is that they can provide new dimensions of depth and extent in learning which make possible a better content both qualitatively and quantitatively.

(5) Motivation. That students were not influenced by strong motivational sequences in their evaluations of learning is revealed in both the control class (Control 237) and in its counterpart as an experimental class (Experimental 240, 28) where the profiles were fairly level even at points where the teacher used personal motivation.

Recommended classroom applications. Hence, in the teaching of an algebra unit in equations and problems, the following techniques are recommended as effective (each have been described in previous unit write-ups):

(1) Overhead projectuals
(2) Group Tutor Device
(3) Grease pencil on acetate

DATA TREATMENTS

EQUATIONS AND PROBLEMS UNIT X

CONTROL					EXPERIMENTAL				
Profile No.	INFORMATION	Media*	No. of Minutes	Average Rating Per Minute	Profile No.	INFORMATION	Media*	No. of Minutes	Average Rating Per Minute
221	How to solve fractional equations by least common denominator. How to solve fractional equations with variables in denominators	30 & 9	12-27	56%	222	same	47&23	17-34	57%
225	How to solve fractional equations of 2nd degree	30	10-30	58%	226	same	47,23 30	1-23	58%
227	Solving $\frac{1}{2}p + \frac{1}{w} = 12$ $\frac{1}{p} - \frac{2}{w} = -4$ simultaneously	30	28-38	50%	230	same	47, 23	33-38	54%
231	How to solve number, digit and coin word problems	30	10-35	58%	234	same	47, 37 23	5-40	56%
233	How to solve investment and geometric word problems	30 & 9	27-43	56%	236	same	47, 23	28-43	56%
235	How to solve time, rate and distance problems	30 & 9	22-40	56%	238	same	47, 23	35-43	55%
237 239	R x T - D problems	30 & 9	15-40 13-28	56%	240 242	same	47, 23	22-42 10-30	55%

Table VI

DATA TREATMENTS

EQUATIONS AND PROBLEMS UNIT X

CONTROL					EXPERIMENTAL				
Profile No.	INFORMATION	Media*	No. of Minutes	Average Rating Per Minute	Profile No.	INFORMATION	Media*	No. of Minutes	Average Rating Per Minute
241	How to solve a word problem involving swimming pool	30, 31 9	32-40	60%	246	same	23&47	20-25	45%
243	How to set up and solve a mixture problem	30 & 9	28-40	48%	246	same	47&23	35-43	52%

*These numbers indicate the types of media used

9 - Questions to Class
23 - Locally Made 10" x 10" Slides
30 - Chalk writing
31 - Chalk drawing
37 - Films - black and white sound
47 - Writing on acetate on the overhead projector

Table VI

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE EXPERIMENTAL AND CONTROL CLASSES IN A UNIT ON EXPONENTS AND RADICALS

Control group learning profiles 249 through 271 formed the subject matter basis upon which the unit on "Exponents and Radicals" was presented to the experimental group in learning profiles 252 through 272.

Unit Objectives.

The basic unit objectives included (1) to learn the meaning of exponents which were zero, negative numbers and fractions; (2) to find ways of writing very large and very small numbers using powers of 10; (3) to be able to use the general form of exponents laws; (4) to learn how to simplify, add, subtract, divide and multiply radicals; and (5) to use exponents in finding the roots of numbers.

Communications Media in the Unit.

The media which were selected to improve instruction included the following, listed in order those ranked highest in profile ratings first: chart, group tutor device, media combination of overhead and tape recorder, filmstrip, grease pencil on overhead, discovery approach, lecture, overhead slides, and individual study. Analysis of conditions of utilization of each communications media and instructional procedure helps to clarify the order of the ranking.

Chart. A cut-out, graphic representation of a chart illustration of the Pythagorean Theorem ranked first in this particular unit. The chart was student-made. It included squares showing clearly the number of units in each of the major parts of the chart. The topic contributed to a high level of learning because it was relatively new information and the theorem provided an interesting synthesis of several principles and methods studied. The rating of the chart (E 270, Min. 35-39) was not as high as the Group Tutor Device on this particular day (E 270, Min. 21-25), but by averages for the entire unit the Group Tutor Device ranked second.

Group Tutor Device and the Cross Media Approach. Questions projected by the overhead with students writing their responses followed by adding the answer on the screen so that students could immediately check their work resulted in the next greatest learning recorded in the experimental classes. A tape recording paced the presentation of the Group Tutor Device (E 260, intermittently from Minute 5 to 30) with greater learning resulting than an unpaced presentation in the control group (C 251, Min. 13-17 and Min. 31-35).

It is interesting to note that this experimental class was completely automated with the audio visual devices carrying out explanations as well as visual illustrations. Only toward the end of the class did the teacher step before the class to go over some answers to a short quiz. Reasons for the higher learning during this class session were (1) the cross media approach; (2) the lack of pressure by the teacher upon the class with the consequent feeling of self-reliance for learning on the part of the students; and (3) the detailed, step-by-step approach of the fully programed class.

Combination of Overhead and Recordings. The same programed class presentation which brought the Group Tutor Device to a top rank brought the combination of overhead slides and recordings to a close third place. The recordings with the visuals were capable of holding student interest and approaching their senses by two paths.

Filmstrip. An appropriate filmstrip* yielded a high level of learning (E 252, Min. 14-29). The use involved showing selected frames and the use of grease pencil on the overhead in conjunction. When the teacher interrupted the filmstrip to ask a student a question, learning decreased sharply (E 252, Min. 24) and then increased when the filmstrip continued.

Grease Pencil on Acetate. Ranking fourth in the experimental classes, the grease pencil presentations developed by the teacher as the class progressed were effective because they were directly related to those things which the teacher deemed important. And, realizing this, the students felt the material presented was particularly significant.

The procedure paralleled chalkwriting and questions directed at the class in the control group. Covering the same topic, the experimental group rated their learning by grease pencil on the overhead at 62% (E 252, Min. 31-42) in contrast to the control group rating learning at 58% (C 249, Min. 10-35).

Questions to Individuals. A pattern of instruction was for the teacher to ask students questions in an attempt to implement the "discovery approach to learning. However, he was also concerned with covering a certain amount of subject matter during the year (due in part to departmental tests) so he actually expected very specific answers, without much "discovering," to enable time to be used economically. Since this approach strictly indicated criterion measures expected of the students by the teacher, the students indicated considerable learning.

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*Exponents & Logarithms. Jam Handy Organization. n.d., Approx 55 frames. black and white. (Kit III - Algebra Series).

Lecture. Ranking seventh in profile ratings of learning, immediately below questions, lectures--when presented--were fairly effective with an average profile rating of 55% in contrast to only 50% in the control classes. They were more effective in the experimental group because they were used in conjunction with the communications media and the media required less time for lectures which were hence briefer and more to the point.

Overhead projectuals. Locally made overhead slides were effective but ranked somewhat lower because they were often used to present routine information in order to save some teacher time and effort. In some individual cases, such slides** presented with the additional visual explanations made possible with grease pencil, resulted in higher learning (E 266, Min. 16-32 as contrasted to C 263, Min. 18-38). In general, however, not many projectuals*** were developed for the unit since the topic did not lend itself extensively to this means of graphic representation.

In those cases where overhead slides were appropriate, improper use by the teacher caused lower increases in learning than would have been otherwise possible. The teacher and the audio-visual specialist had planned a slide# to introduce irrational and rational numbers. However, the teacher used lecture and questions to the class to introduce this topic (E 264, Min. 6-9) before the slide was introduced (E 264, 9-12); hence the new part of the material was quickly taken away by lecture before the experimental material

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**"Square Roots." 10" slide. XI J6. 1962. Prepared by New York State Education Department, Division of Educational Communications. yellow & black.

***Set of 10" slides. XI A-J and J 1-6. 1962. (Same source).

#"Rational and Irrational Numbers", 10" slide XI G. 1962. (Same source). Multiple color, 4 stage overlay.

(the slide) could be presented. The brief lecture was enough to assist recall of this information which most of the students had studied in the previous year. During the slide presentation (E 264, Min. 10) the teacher reminded the class of having had this before--and the profile dropped. However, learning increased with the use of grease pencil on the slide to show examples.

Learning increased with the brief grease pencil example (E 264, Min. 13) used to introduce a principle on a slide## (E 264, Min. 14-17). In comparison to the control group (C 261) learning was significantly higher in the experimental group (E 264).

A second slide### included some examples leading up to a principle. Learning increased during the slide presentation (E 264, Min. 17-22) even when the slide was not presented by a progressive revealing of information as had been planned.

Individual study. Individual study was among effective procedures in the experimental class sessions. This was partly due to the fact that after the effective presentations by communications media, the students found that working at their own rates gave them time to assimilate and see ways in which the new learnings would assist them in their "homework."

Special Experimental Approaches.

Some experimental approaches could not be ranked with the others due to special problems.

##"Principle I, Multiplication of Radicals," 10" slide XI H. prepared by New York State Education Department, Division of Educational Comm., 1962.

###Principle II, Simplification of Radicals," 10" slide XI I. (same source) 1962.

Grouping Procedures. A class session which did not include content on the unit was not ranked with the techniques used in the unit. The class was instructed by a physical education teacher as a substitute. Observation of this substitute guiding the class into small groups revealed some useful patterns, even though the class content was not sufficient to cause a high learning profile (Profile E 258). Had an algebra teacher been there for subject matter content, learning may well have been higher.

Problem Development and Solving by Students. While the students were working in the above mentioned groups, they were asked to make up an algebraic problem to represent each group. A high degree of interest resulted.

As a follow-up the presentation of a problem from each group was planned. One was presented during an election (while the teacher counted the ballots). Before the students had worked out the answer, the teacher turned to another topic (E 262, Min. 11) saying that (1) perhaps the class would come back to the problems some day, and (2) the class can finish working out the problem on their own.

A little later a student said he had the answer. It was indicated as incorrect by the student who had made up the problem. The former student tried to go into this but he was quieted by the teacher.

The students may have gained the impression that work they initiated was not acceptable in the view of the teacher. This attitude was also indicated in the teacher's rejection of the possible value of a day in the school when a student in each class was selected to serve as teacher for the day.

Programed Materials. Six students who had very low grades were given programed textbooks[&] to work on the section on exponents. No special instructions were given to the students so that an evaluation could be made of the programs as a self-instructional approach. Each indicated that he read the instructions accompanying the materials.

In evaluating the program, each of these special students agreed that he liked the opportunities it provided for going at his own pace. Since the students were working individually, outside the classroom, no profile analysis of their learning was possible.

Programed Study Sheets. Some programed study sheets were introduced (Experimental 254 and 258) to provide general review for the students. Since these were not on the subject matter content of the unit, they were not ranked with the other media. Had they been ranked they would have fallen in eighth place (between lecture and overhead slides) on the listing of media in order of effectiveness.

Regular Classroom Procedures.

The highest rating of the ranked procedures of the control class was not as high as that of the experimental class. Among the control group procedures the ones directly involving students were the most effective.

Questions to the Class. Questions directed at the class, with specific answers expected, was highly effective as far as learning in the control classes was concerned because the criterion measures expected were thus indicated.

[&] "Exponents," Unit Three of Fundamentals of Algebra, Part II. TMI - Grollier, 1961. 235 frames.

EXPERIMENTAL CLASS			CONTROL CLASS		
Rank	Actionable Item	Profile Rating	Rank	Actionable Item	Profile Rating
1	Chart	61	1	Questions to class	58
2	Group Tutor Device	59.6	2	Individual Study	54.1
3	Slides and recordings	59	3	Chalk writing	54
4	Filmstrip	58.5	4	Involvement	52
5	Grease pencil on acetate	56	5	Ques. to individuals	51.1
6	Ques. to individuals	55.6	6	Chalk drawing	50.7
7	Lecture	55.1	7	Lecture	50.4
8	Locally made 10" x 10" slides	54.75	8	Joking	48.5
9	Individual study	51	9	Oral reading by students	38

Table VII Media and Procedures Ranked by Profile Ratings

Individual Study. Individual study was found to be second in effectiveness, indicating that the students felt that they could learn better largely on their own (but with some individual help from the teacher) in comparison to the other means of presenting information in the control classes.

Chalk Writing. The teacher felt more at ease with chalk-talk presentation than with any other means of communication (except perhaps lecture) and this provided a graphic visual medium of communication which was clear to students.

Involvement. At times students were involved in working at the board and this proved to be an effective procedure, particularly with the opportunities provided by this technique for more than one student to be involved.

Questions to Individuals. Questions directed to individuals were effective, but not as effective as questions directed to the entire class. The primary reason for this was that the individually-addressed questions were usually based on a problem of concern only to one individual rather than on something of concern to the entire class.

Chalk Drawing. The teacher had a remarkable ability to make clear cut chalkboard drawings. This was reflected in the sixth place rank among control group procedures. However on this and the three following procedures, the profile rating was significantly lower than the ratings on the last three procedures listed in the experimental group ranking.

Lecture. Lectures by the teacher were seldom of long duration. They were informal; and if any notes were used they were in the form of very broad outlines. The lectures usually were interjected between other classroom procedures. They often included a moral note concerning the ineptness of ninth graders.

Joking. Humor often would be somewhat related to the topic at hand.

Oral Reading by Students. For brief periods, students would occasionally be asked to read from their completed homework papers or from the textbook. The low profile rating indicates that it was not highly effective, and yet control group procedures were so limited in number that this procedure was listed among the top nine.

Recommended Classroom Applications. On the basis of observation and study during the unit, several suggestions which would prove helpful to the classroom teacher resulted.

Grouping for Small Group Learning. Observation of a teacher such as a physical education instructor can provide some helpful hints for the physical aspects of grouping a class for small group instruction. General directions are of course given with clear delineation of who is to be in which group. The groups then move into the groups with a clear understanding of what is to be their assignment and the role each is to play within his group. Rather than take the time of the whole class to put the groups into better order--so that within each group students are able to face each other and so that one group does not distract from the other--the teacher patiently goes from group to group helping each individual group to become better arranged.

Programed Tape and Slide Presentation. Such relatively high profile ratings occurred when a lesson was presented (E 260) by a combination of media that the lesson merits a fairly detailed explanation. A similar pattern could be followed by any teacher seeking to improve his level of instruction.

A careful analysis was made of presentations of some of the unit content in control classes (notably C 249 and 251). Available media were reviewed, and it was determined that a totally programed presentation utilizing overhead slides and a tape recording would be the most effective approach. After the students were given instruction by tape and overhead transparency, the students were told that a quiz would follow the class presentation. Goals were stated and then overhead slides presented information, the students checked their knowledge of the information by the Group Tutor Device, more information was described by other transparencies, and there was additional student checking by the Group Tutor Device. The Group Tutor Device was paced so that the students went rapidly through the materials; however none seemed to object to the speed. Each student was given a lined answer sheet with numbers corresponding to group tutor items. Space provided for student answers and questions to be asked later in class.

After the presentation of a quiz on the class content was given with the class averaging 90.13% (Range 60-100). This was considerably higher than in classes which were not programed. Time remained for the original copies of the test papers to be turned in to the teacher while the students had a carbon copy remaining which they used to check the accuracy of the responses. This was achieved by the teacher giving them the correct answers. There were few questions on the quiz.

The completeness of the coverage offered by the media and techniques was indicated by the fact that when the teacher indicated that the quiz only drew upon part of the material taken up in an earlier part of the class, and that they would have an opportunity to ask questions on any of the material, there were no questions. Six students who had the lowest achievement in the class were told to check out programed instructional materials[&&] which they did eagerly at the end of the class with no students trying to avoid this responsibility.

The profile showed a high degree of student interest by the great variety and the high level of learning during the class presentation. Learning did not increase until the end of the presentation when the review assignment was introduced and when the quiz was given. Learning remained low during a standard lecture discussion period (E 260, Min. 37-42).

Student discipline remained at a high level during the presentation.

Graphic Presentations. Different graphic means of presentation should be considered for appropriate topics. A filmstrip may well provide the most effective, systematic presentation of a topic (as exponents were introduced

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[&&] Teaching Materials Corporation. "Exponents and Radicals" Unit III of Fundamentals of Algebra Part II. Grolier. 1961. 470 frames.

in this unit) whereas for another topic a chart possibly even produced by a student (as was the chart of the Pythagorean Theorem) would provide top level learning.

* * *

As in other units, the principle was demonstrated that careful analysis of the teaching situation can guide the teacher toward wise selection of the most effective communications media and techniques available for improved student learning.

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE EXPERIMENTAL AND CONTROL CLASSES IN A UNIT ON QUADRATIC EQUATIONS

Control group learning profiles 271 through 281 reveal the normal patterns of instruction. Experimental group profiles 274 through 282 represented a new, pre-planned pattern of instruction.

Large Group Instruction

Large group instruction was of great interest in the nation and in the school district. It was determined to implement lectures to the large group by media which had proved to be effective in previous units. The following words (from E 276, Min. 25-29) were used by the teacher to introduce the unit to the experimental group, now consisting of two classes meeting together:

> "Next year many schools will be experimenting with what we call "Large Group Instruction". One teacher takes the large group. This frees the other teacher for various things like making up tests, studying, preparing their own lectures, and next year we expect to do more of this type of thing. You are just a small experiment to see how it goes--an experimental class to see two things: (1) can you learn this way, and (2) is it easier to learn this way, is it easy or hard, is it boring to learn this way, do you like it better or do you like it less. These are the things which we are interested in."
>
> "We are more interested in whether you learn than whether you are bored. My class will realize that this is very different from the way I ordinarily teach so it is also an experiment for me. This is the way things are going to be. After all why should two teachers teach 60 people if one person can do it. That is the question, of course. The answer may be one person cannot teach 60 people as well as he can teach 30. This is something we are going to find out. It is not just a matter of one person teaching 60 people because you will be split up into groups and get more or less the ordinary kind of teaching. That is the reason we are here. It is up to you to do the best that you can; and if you are sitting there thinking about other things, you are not going to get the most out of it."

The unit was introduced by the same basic method in both groups. It was supplemented by chalk-talk in the control group (C 271) and by grease pencil on the overhead in the experimental group (E 274). The average profile rating was approximately the same although the beginning was slightly higher in the experimental group than in the control group. This was probably due to moving more rapidly into the subject, whereas in the control group there were few questions directed to the students.

Sub-group Instruction

As the unit progressed a quiz was administered (E 276, Min. 36-44) which provided a basis for separating the two groups into a good and a better group (generally all of the students achieved relatively high scores on the quiz). When the two groups met separately (E 278) the teacher was able to guide the group along more rapidly than usual because he (and she) had a smaller range of differences to work with.

This pattern was followed throughout the unit, with the teachers alternating in teaching of the higher ability group.

Unit Objectives

The primary subject matter goals were (1) to understand and solve quadratic equations, and (2) to solve quadratic equations by completing the square.

Standard Media and Procedures

The following table reviews the ranking of procedures utilized in both experimental and control classes:

CONTROL				EXPERIMENTAL			
	Item		Average		Item		Average
1.	2	Lecture	53.4	1.	46	Group Tutor Device	60
2.	9	Ques. to class	50.2	2.	26	Wall chart	58
3.	4	Joking	50	3.	47	Grease pencil	56.75
4.	12	Involvement	49	4.	9	Ques. to class	53
5.	44	Stud. work prob. on board	49	5.	12	Involvement	44

Table VIII Rank order of instructional procedures

The usual procedures were followed in the control class but with a different emphasis. The teacher lectured much more than usual. Since lecture was to be a key part of large group instruction in the experimental classes, this break from the planned pattern reduced differences between the groups; however, more information was taught in less time in the experimental classes.

Lecture. The students realized that they were being given much valuable information by lecture and found that they were gaining much from this procedure, thus ranking it first among modes of learning in this unit.

Questions to class. Questions to class were high as in the previous unit because they gave clues to criterion measures. They also helped to keep them alert to what they were learning as the questions were asked and answered.

Joking. Jokes were related to lectures and usually had a point related to the subject matter. Hence they fell in third place ranking. However, jokes did not even rank in the experimental classes where students had more procedures to choose from.

Involvement and students at board. Involving students in class activities such as working at the board was a fairly effective procedure.

Experimental Approaches

More information was presented in less time with greater learning on the part of the students by the experimental procedures than by the control procedures. The unit took only 8 days by the experimental procedures as contrasted to 10 days by standard control group procedures (even though more information was packed in than would have been normal through lecture and related approaches). Test results also favored the experimental group.

All of the procedures listed below and in Table VIII were accompanied by lecture.

Group Tutor Device. Most highly effective was the Group Tutor Device. It was particularly effective because it was used in a short segment (E 274, Min. 42-45) of a class presentation and served as a culmination of class activities including other uses of the overhead and wall chart.

Wall chart. The second highest rating went to a wall chart* presenting key concepts presented step by step by pulling strips of paper off to reveal information at the appropriate time (E 274, Min. 8, 24, 29, 34; E 276, 12-14).

Grease pencil on overhead. Lectures were frequently implemented by grease pencil writing and computation on the overhead projector. The ranking in Table VIII shows on the average this technique was very effective. Some individual cases dramatize the difference.

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*"The General Quadratic," 30" x 40" reveal chart, prepared by N.Y.S. Education Department, Division of Educational Communicaions. 1962. 4 colors.

Questions to class. Essentially questions to class were mainly devices for holding interest during lecture presentations. In this light, the procedure may be considered to be relatively poor in spite of ranking fourth.

Involvement. A low fifth place was held by activities involving students. Realizing that the real business at hand for learning was the lecture, the procedure was too slow for high student learning.

Recommended Classroom Procedures

The total effect of large-group instruction in which the new media played an integral part was greater and more rapid instruction. Student discipline was excellent. On the basis of experience in working on this unit, it was possible to make these recommendations for classroom practices:

Provide large-group instruction where facilities are adequate. A 40 foot square classroom is adequate for large group instruction of 60 students. Although students are fairly close together, they and the teacher prefer the close teacher-student contact possible. So that students can see clearly and have the benefits of visual media, projection equipment should be made available. The following communications media helped to make a high level of learning through lecture to the large group possible.

Also important to the success of the instructional patterns described above was (1) the availability of another room so that students could be divided according to ability and instructed with a restricted range of differences to contend with; and (2) the freeing of one classroom teacher to construct particularly good tests and work on lesson plans.

Use the Group Tutor Device at key points. Although extensive use of the Group Tutor Device was not evaluated in this unit, it was highly effective when used at a key point. Student involvement such as this where he immediately can check his own personal response will result in high learning.

Represent key ideas on a wall chart. Certain concepts which need to be kept before the class for a long period of time can be put on a wall chart so that the overhead projector can be used for other types of material. Strips of paper on the chart can cover portions which need to be taken up later.

In using new approaches, customary ones such as using grease pencil on the overhead can contribute much in conjunction. Use of the grease pencil on the overhead projector proved to be effective in this unit as in other units. Particular advantages accrued in this unit involving large-group instruction because students could see the enlarged image clearly on the tilted, matte screen hung from the ceiling.

ANALYSIS OF LEARNING PROFILES

COMPARING LEARNING IN THE EXPERIMENTAL AND CONTROL CLASSES IN A UNIT ON INDIRECT MEASUREMENT

Odd-numbered profiles 283 through 291 reveal the content of a unit or indirect measurement as presented by normal instructional procedures. Even-numbered profiles 284 through 292 represent the same content presented with some standard procedures and some new media in a large-group instruction setting.

Unit Objectives

The many applications of indirect measurement provided unit content of a high interest level for the students. Unit objectives included were: (1) to find ways of measuring distances which cannot be measured directly; (2) to review understandings of angles and triangles; (3) to learn three ratios between the sides of a right triangle; (4) to study these ratios as functions of the size of an acute angle in a right triangle; and (5) to measure by three trigonometric ratios.

Instructional Procedures Compared

Table IXreveals the ranking of the instructional procedures in the experimental and control classes. It is important to note that large-

CONTROL		EXPERIMENTAL as part of large-group instruction	
Description	Rating	Description	Rating
1. Wall chart	46	1. Text and other book illustrations	54
2. Lecture	44.4	2. Ques. to class	51
3. Questions to class	44	3. Involvement	49
4. Oral reading	43	4. Lecture	45.2
5. Ques. to students	40.5	5. Locally made 10" x 10" slides	45
6. Chalk writing	40	6. Grease pencil on overhead	45

Table IX Rank order of Instructional Procedures

group instruction was continuing as a primary pattern for the experimental group. Within this pattern, the various instructional procedures shown were utilized.

The average level of the experimental group's profiles was slightly higher than that of the control group. The general levels in both groups were not high. This may be partly attributed to the fact that the textbook had a well-written, interesting, well-illustrated chapter which provided basic information to both groups out of class as well as in class. Superior achievement on the unit test by the experimental group may be attributed to the fact that the experimental procedures were more effective in preparing students for efficient use of the text material. For instance, in the experimental group the attention of the class was drawn to the text illustrations with the result that this was ranked highest of the instructional procedures in the experimental classes.

Chalk-talk vs. grease pencil on the overhead. Considering profiles 289 and 290, the profile was on the average 5 points higher in the experimental class. The teacher used these media to go over homework problems. This lasted for nearly the whole period in each class. Since this procedure of going over homework problems in math classes is a popular one, if learning can be increased by using the overhead projector instead of the chalkboard, the use of this new media should be encouraged.

Another comparison of chalk writing with writing on the overhead projector may be made on profiles 287 and 288. During minutes 32-35 of each class a definition of angles of elevation and depression was given. In the control group this was done by chalk writing which had an average reading of a little less than 50. The experimental group was taught this definition on the overhead projector. This item had a rating of a little over 40.

Another comparison of chalk-talk with the use of the overhead projector may be found in profiles 285 and 286. In the control class the definition and illustrations of sine and cosine functions were presented by chalk-talk, and lasted from the 30th to the 33rd minute. The average rating was slightly less than 40. In the experimental class this was taught from the 31st to the 35th minute with an average rating of about 55.

Still another comparison of these two methods of presentation may be made with profiles 283 and 284. In the experimental class tangent ratio was taught from minute 35 to minute 40. The average rating was a little less than 50. The control group was taught this information from minute 32 to minute 40 with an average rating of about the same.

Lecture in both groups. When lecture alone occurred in both groups, the average rating during the unit was higher in the control group. Factors contributing to this were: (1) the teacher was not as much at ease in the large group instruction situation where he was using a formal lecture approach; (2) in the control group, the teacher was not only more at ease using an informal approach, but because of his unusually careful preparation for the large-group lecture he presented atypically large amounts of information by lecture in the control group. The latter situation also contributed to decreasing the amount of gain which the experimental group would have had--had the control group been taught by normal procedures as had been planned. Normally the teacher did very little lecturing.

Student Interest in New Media

By the time of year in which this unit was taken up, the students in both classes had become acquainted with the different types of communications media. A tradition in the school was for the students in each class to elect a fellow student to serve as teacher for one day. The day is represented by Profiles A and B which follow Profile 284 in the Atlas.

The students were free to select instructional procedures which they preferred--although they were to take the job of teaching seriously. In both classes the students preferred to work with the overhead projector, Group Tutor Device, prepared overhead slides, and grease pencil on acetate. The higher and progressively higher profile in Profile A was probably due to the fact that the student teacher was well-informed, nicely poised, and was able to write much more clearly on the overhead projector.

A side effect of the study will no doubt be that of the many students in these classes (all of the students were college-bound) who will eventually go into teaching, several will remember their experience in this research project and plan toward the use of the new media as they go through teacher preparation programs and eventually go into teaching.

Recommended Classroom Procedures

Indirect measurement is a topic which lends itself to many different communications media approaches. Some which were explored in this study can be recommended for the classroom:

Prepare some overhead slides in advance. Several copies of a plain right triangle on a sheet of acetate will facilitate work on the overhead with grease pencil.

A slide with a triangle with movable sides* is also helpful for clarifying concepts about different types of angles--as well as attracting student interest. Several other slides were used in the unit;** the person planning an improved instructional program will find many different applications of indirect measurement lend themselves to graphic drawings for overhead projection.

Draw attention to textbook illustrations. Most textbook publishers now include many illustrations. Drawing attention to these illustrations and helping students to learn how to learn from them will prove fruitful.

Give students opportunities to use indirect measurement through work with instruments. Although not included in this unit, the classes were introduced during review sessions (Profiles 300-302) to the transit and the sextant. A high degree of interest can accompany such activities.

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*"Elements of Angles", 10" action slide prepared by N.Y.S. Education Department, Division of Educational Communications. 1962. 3 colors.

**"Ratios", 10" slide (same source) 1962. 3 colors.
"Sum of the Angles of a Triangle" (same source) 1962. 4 colors.
"Tangent Ratio" (same source) 1962. 2 colors.
"Cosine Ratio" (same source) 1962. 2 colors.
"Sine Ratio" (same source) 1962. 2 colors.

ANALYSIS OF LEARNING PROFILES

RECORDING YEAR-END REVIEW SESSIONS

Profiles 293 through 311 were devoted to review of the year's work. Because a pattern in the school required concentration on preparing for a departmental final examination upon which student grades would be based, most of the time was devoted to taking up a heterogeneous assortment of topics which did not fall into neat patterns of subject matter or instructional procedures.

Instructional Procedures Used in Reviewing

Primary reviewing was accomplished by a basically traditional approach. Table X would be interpreted with consideration of the fact that the greatest amount of time was devoted to grease pencil writing on the overhead in the experimental groups and to chalk writing in the control groups. The other items on the chart were not employed frequently--and the general level of profile ratings was relatively low. Because of these low ratings, little meaning can be gained from the table--except to see that regardless of your procedure, review is not highly productive for learning. The fact that joking was ranked first in the experimental group--and involvement in the control group--indicates that just any change in the instructional pattern of review which might offer even a little divergence from the student content which they had studied through the previous two years would increase learning. For learning to occur an element of newness was necessary. As has been noted before, the joking by the teacher was related to the course content.

Motion picture recording increases use of media and learning. The pattern of a traditional approach to review was broken in an experimental class (E 300) by producing a film of the class session. The teacher was told that it would

REVIEW PROFILES

	Experimental			Control	
	Description	Rating		Description	Rating
1.	Involvement	50	1.	Joking	54
2.	Introduction	44	2.	Objects	47
3.	Chalk writing	39.33	3.	Introduction	40.5
4.	Lecture	39.8	4.	Lecture	39.85
5.	Questions to class	39.4	5.	Individual study	39
6.	Individual study	38.33	6.	Chalk writing	39
7.	Questions by indiv. students	38	7.	Grease pencil on slide	36.33
8.	Joking	36	8.	Ques. by individual students	33
9.	Objects	35	9.	Students working probs. on board	33

Table X Rank order of Instructional Procedures

be important to represent different types of communications media in the film. The research team and the teacher planned media to be produced.

Although the teacher had been sometimes reticent to introduce new media in his classes--particularly in review sessions--the motivation of having something for the motion picture stirred him to conduct himself very ably in use of the media with the result that the profile showed some of the greatest increases made during the review sessions. Media to cause these increases were a filmstrip*, grease pencil writing and drawing on the overhead, and use of an object (the transit).

That the new media contributed to the increased learning is shown by the fact that on the same day the teacher stepped into the control group (C 301) and attempted an unusually active variety of traditional activities--without the increases in learning which had occurred in the experimental group.

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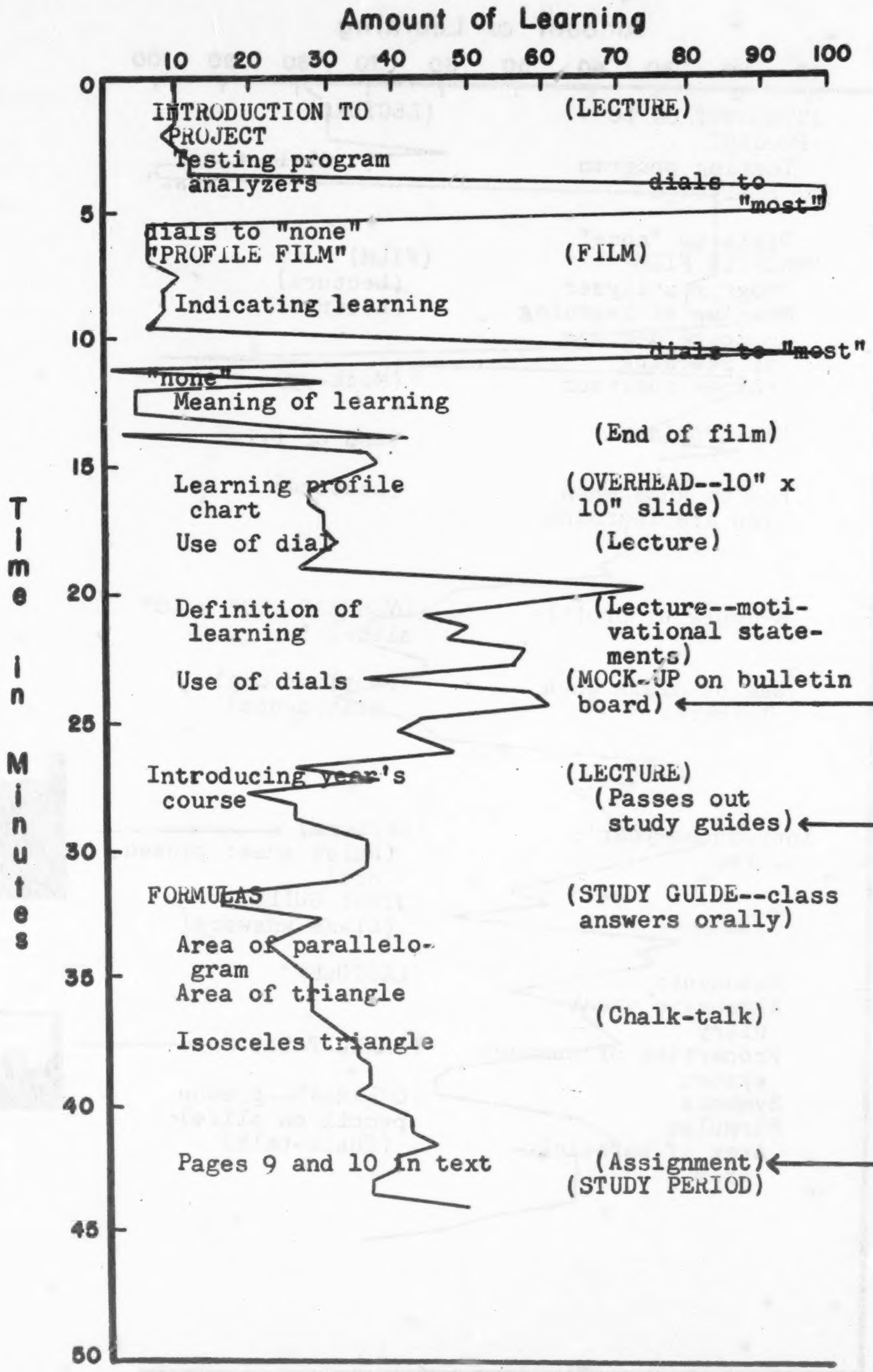
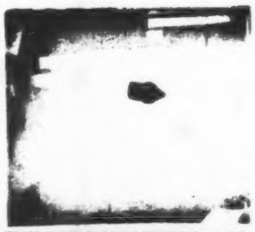
*"Inequalities," op. cit.

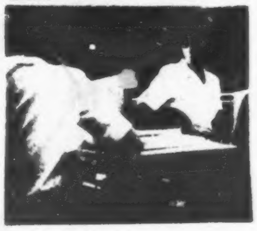
CONCLUSION

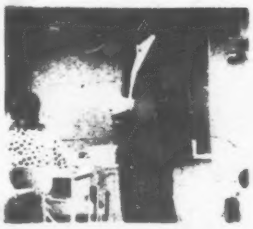
The Atlas of Learning Profiles, unit analyses, and the Introduction provide some interpretations of the learning as recorded on the basis of program analysis equipment. The reader will find that these presentations will suggest new approaches to further analysis of the profiles to investigate facets of problems which are particularly of interest to the person.

With the completion of learning profile three-hundred and eleven another major phase of the research study was completed. The research team knew that the program analyzer technique could be carried on through-out the two entire school years--first in general science and second in algebra. This opens the way for future research studies by which this means of analyzing the process of learning in detail can be appliedin various school situations.



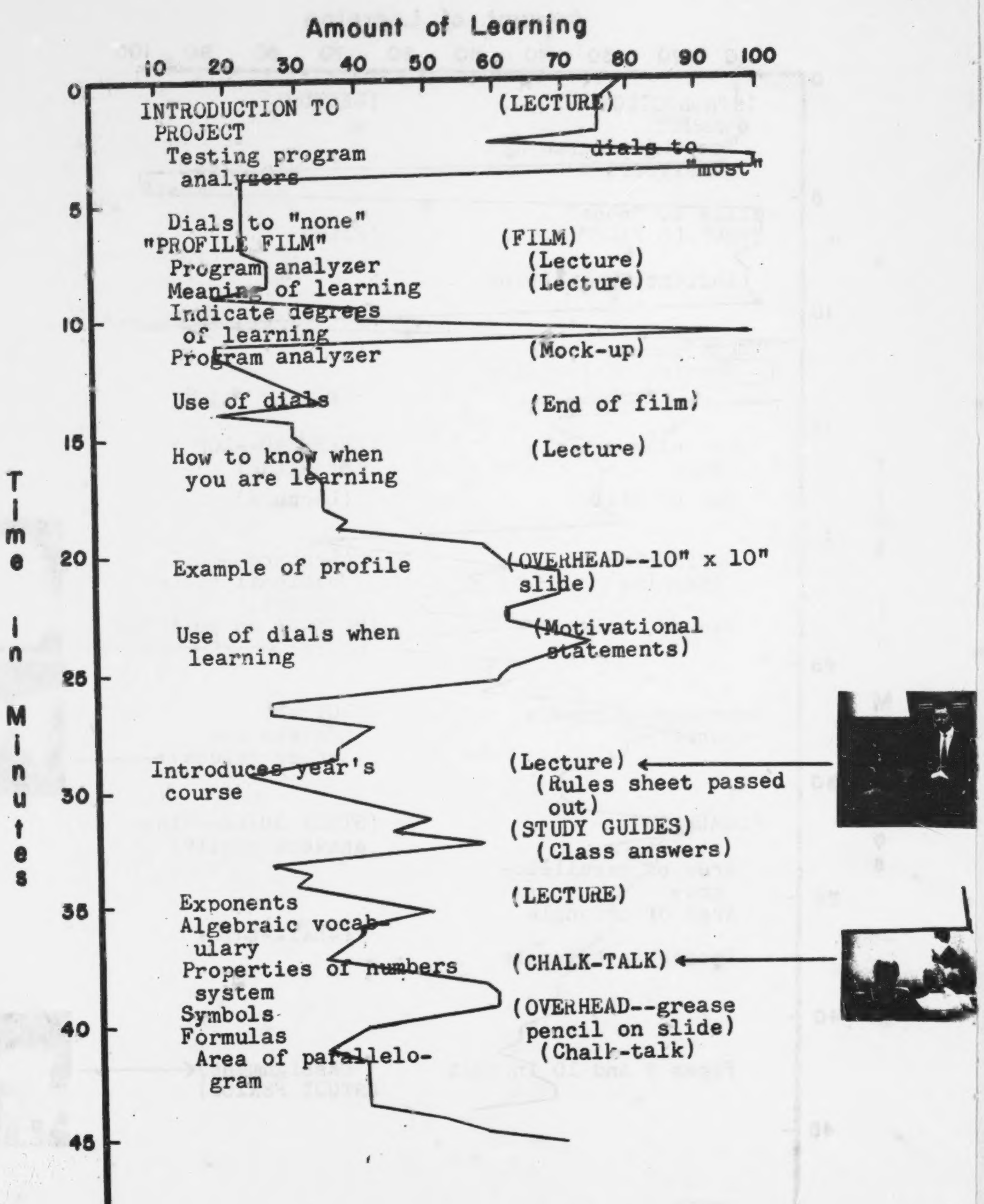






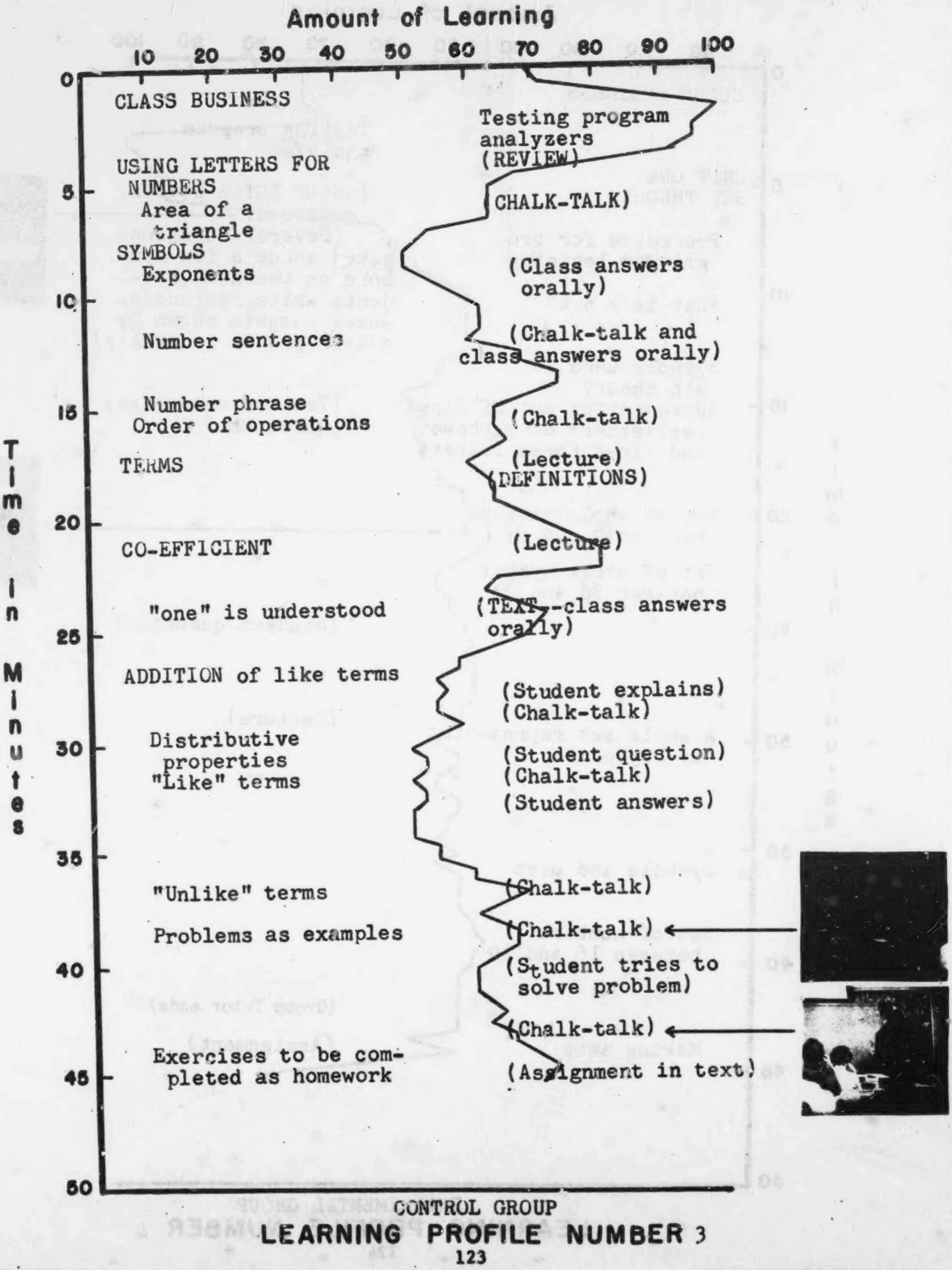
CONTROL GROUP

LEARNING PROFILE NUMBER 1



EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 2



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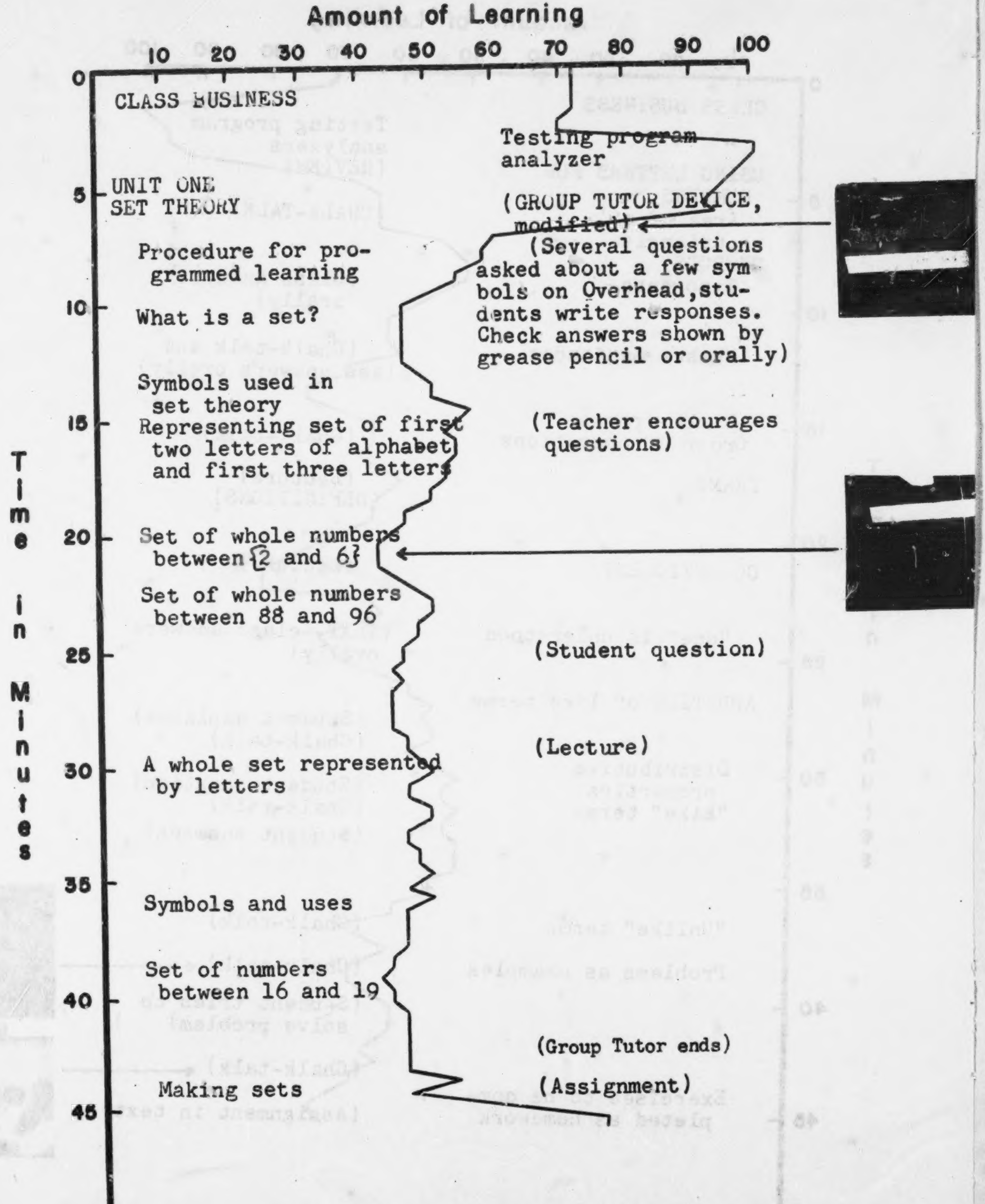

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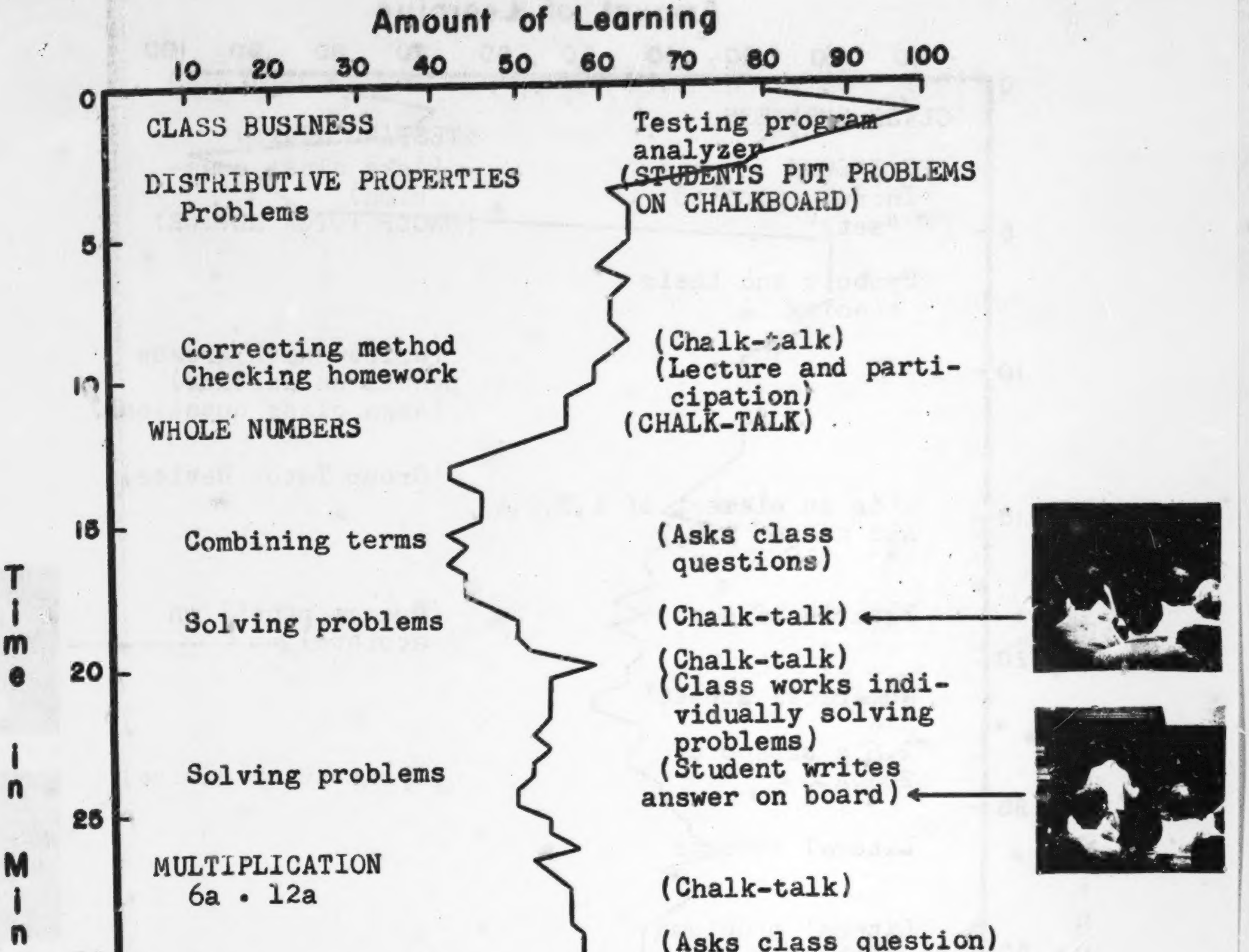
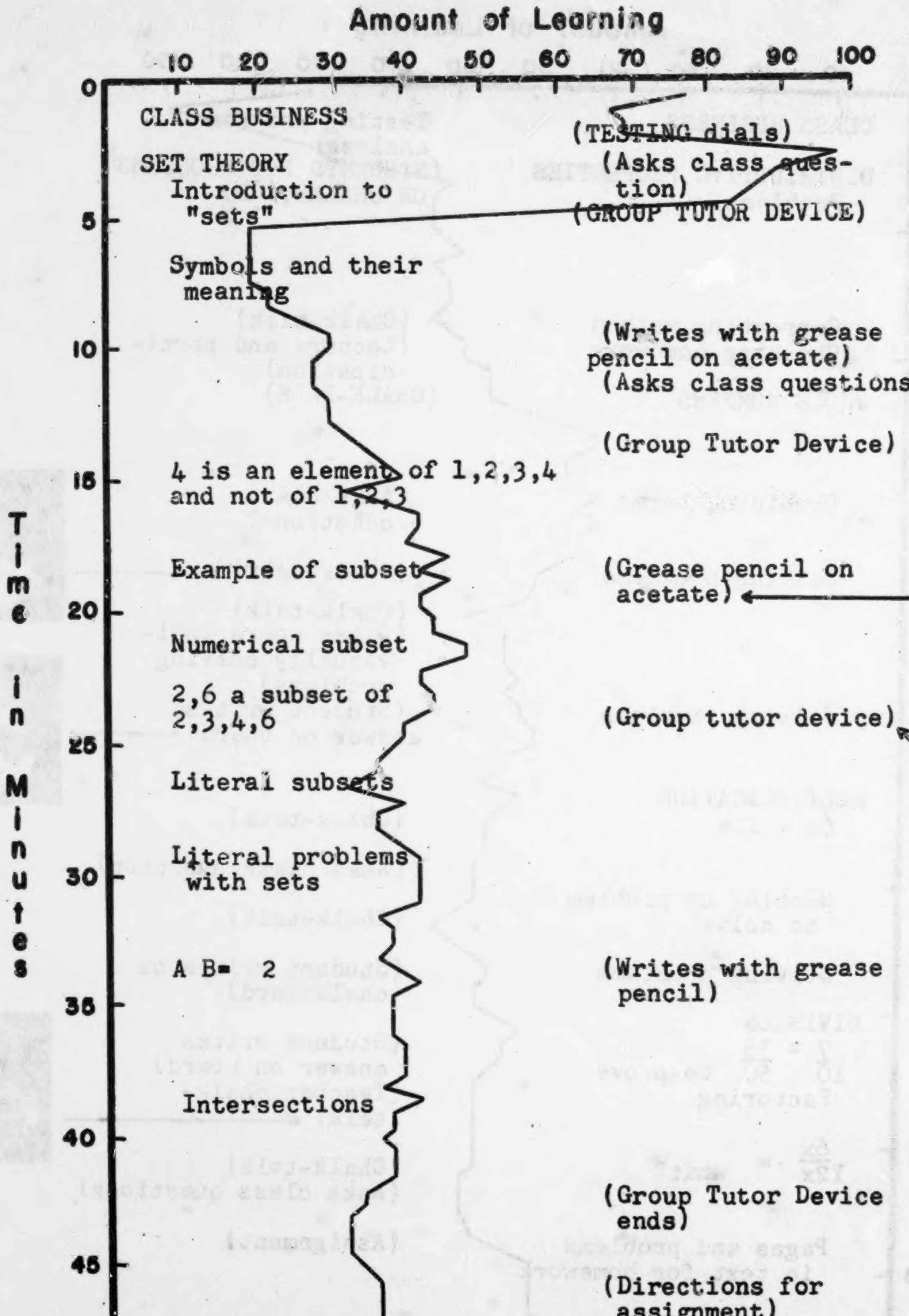
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 4



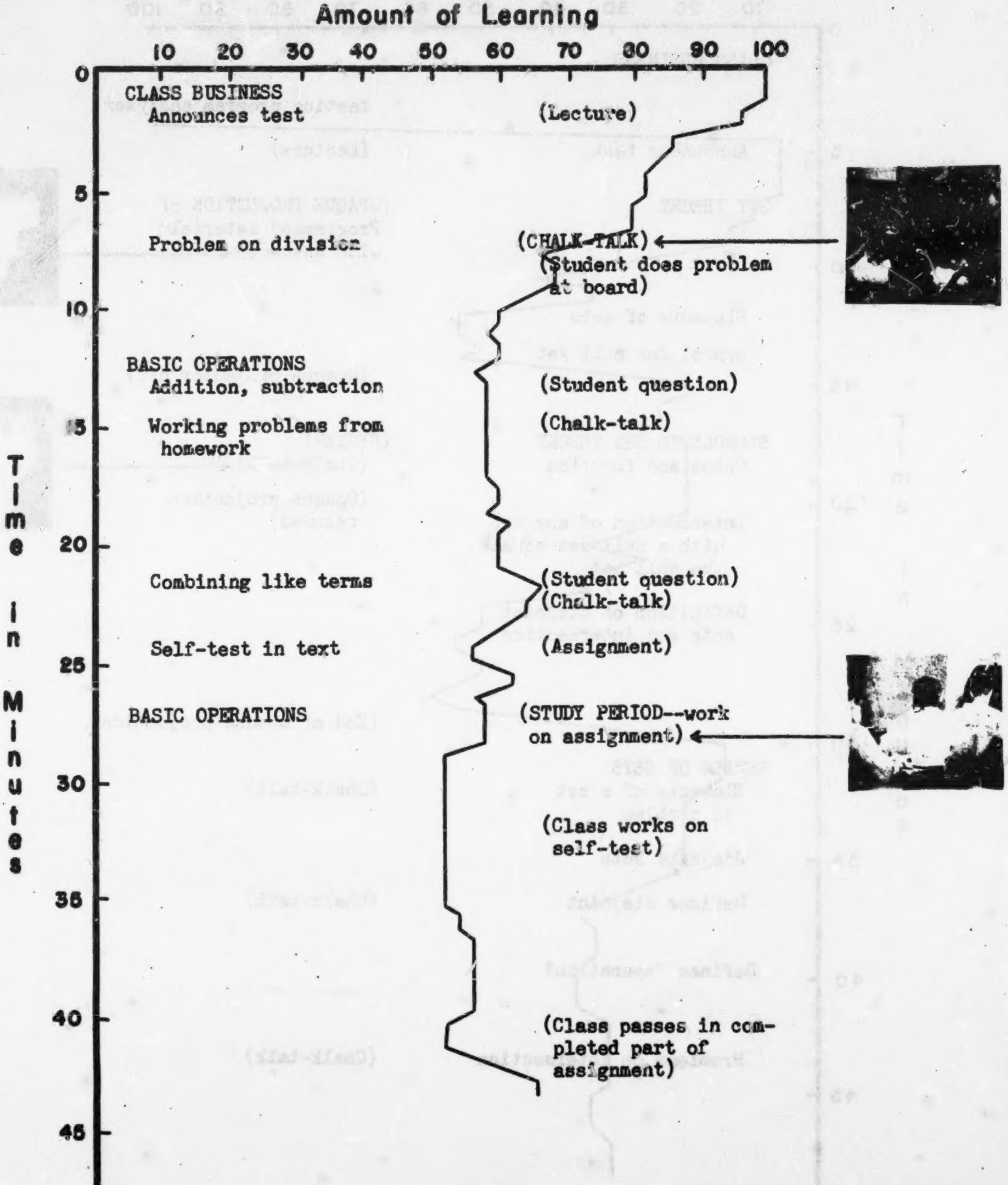
CONTROL GROUP

LEARNING PROFILE NUMBER 5

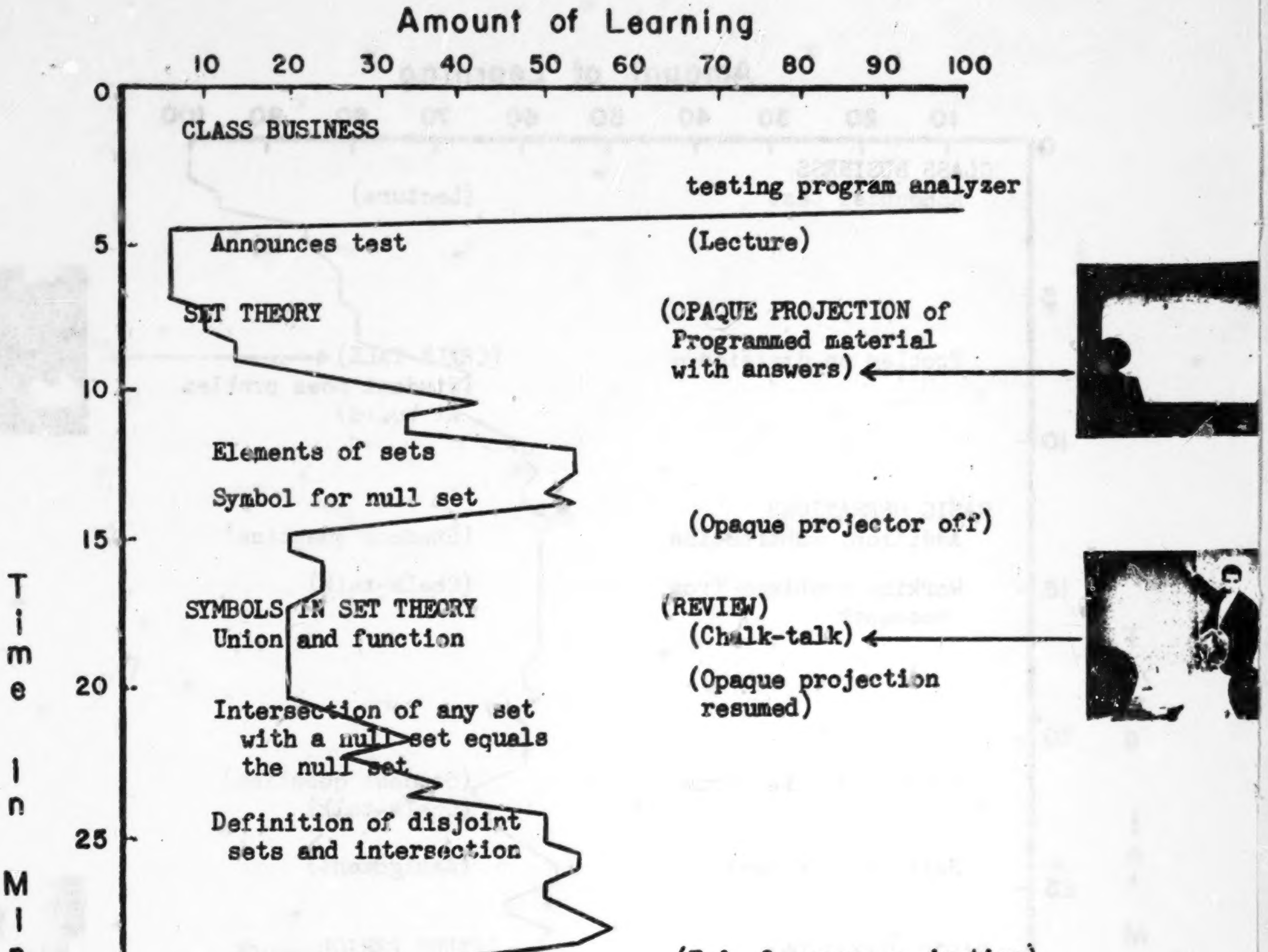


EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 6

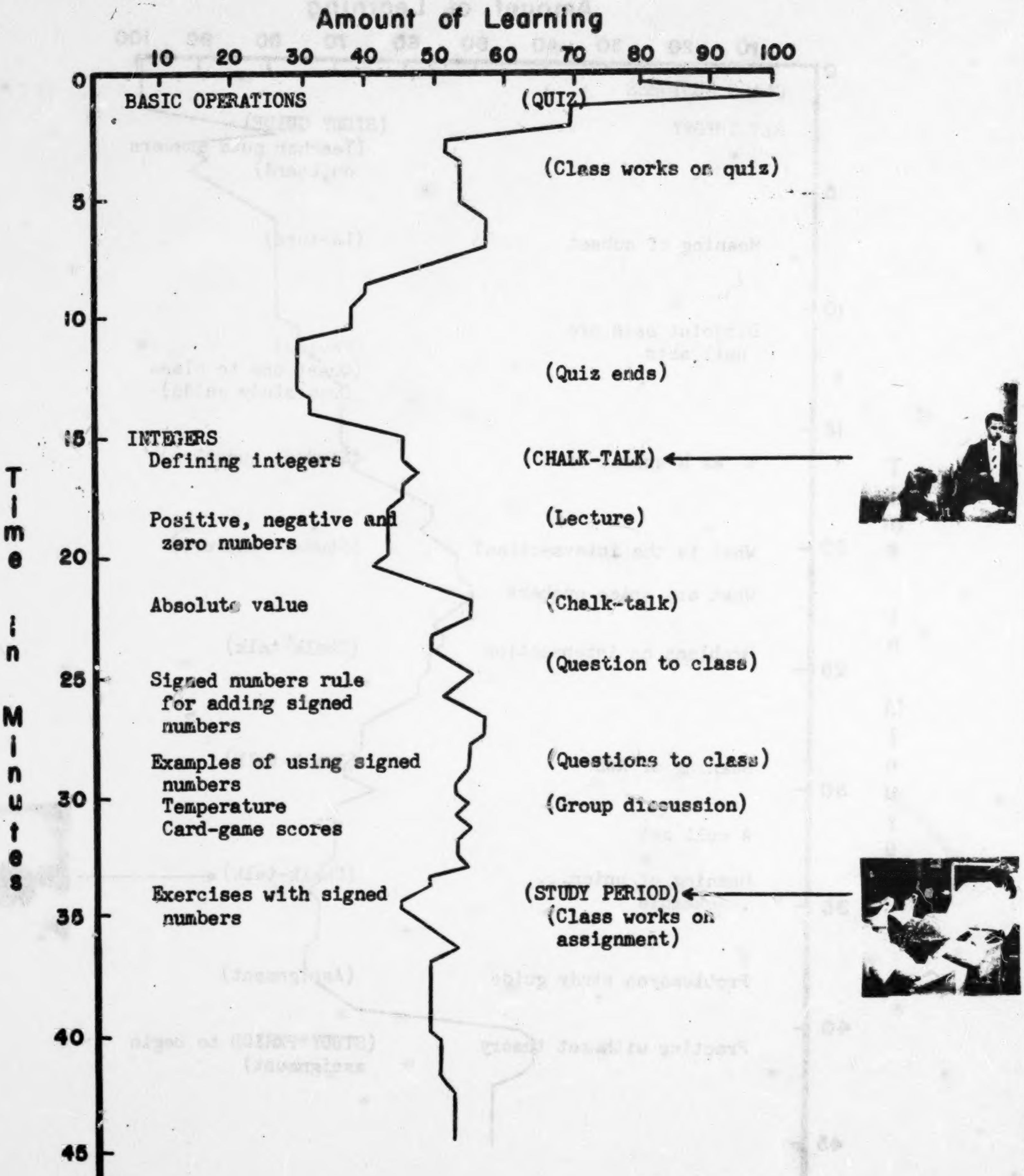


CONTROL GROUP
LEARNING PROFILE NUMBER 7



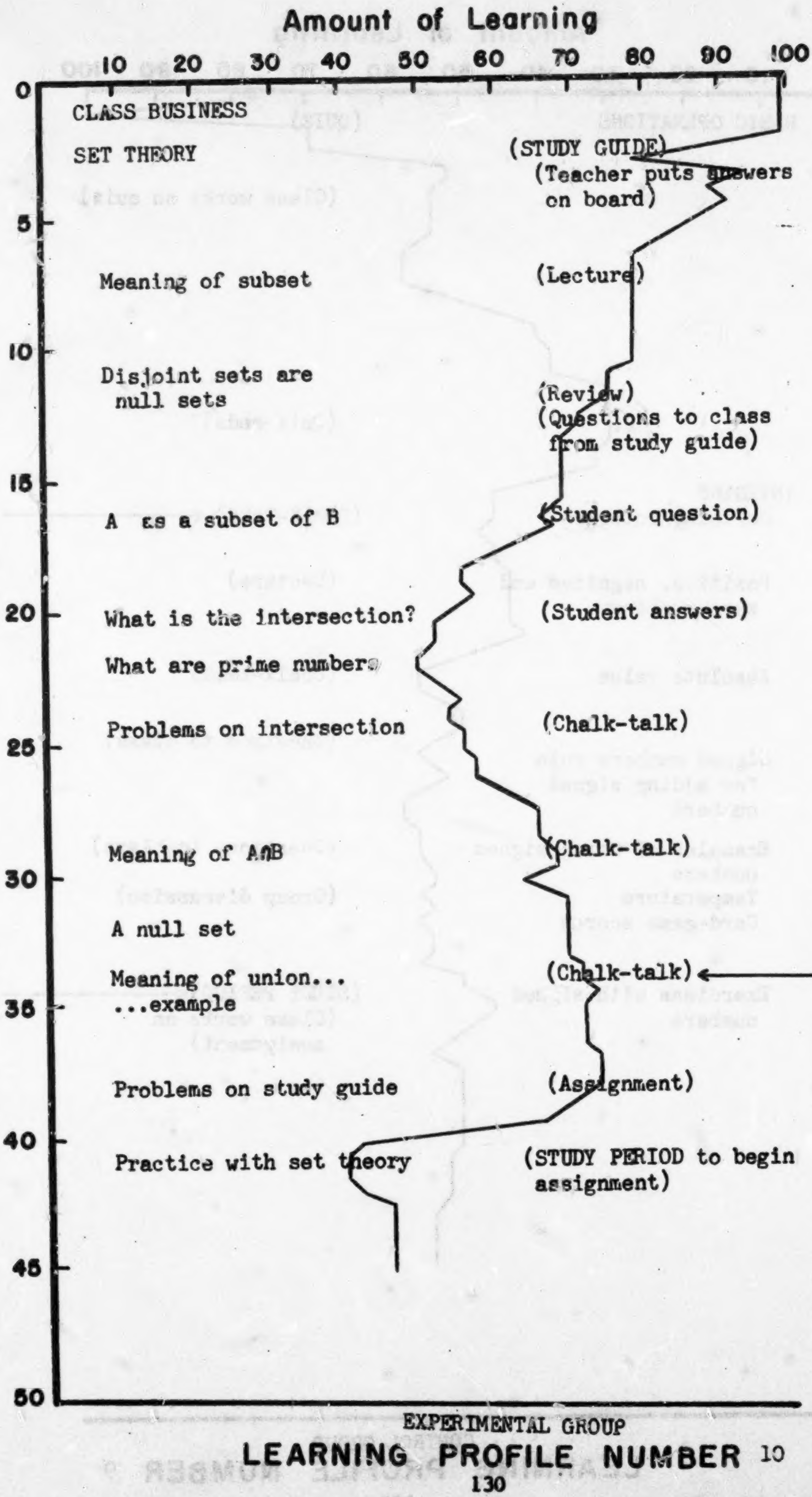
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 8



CONTROL GROUP

LEARNING PROFILE NUMBER 9



EXPERIMENTAL GROUP

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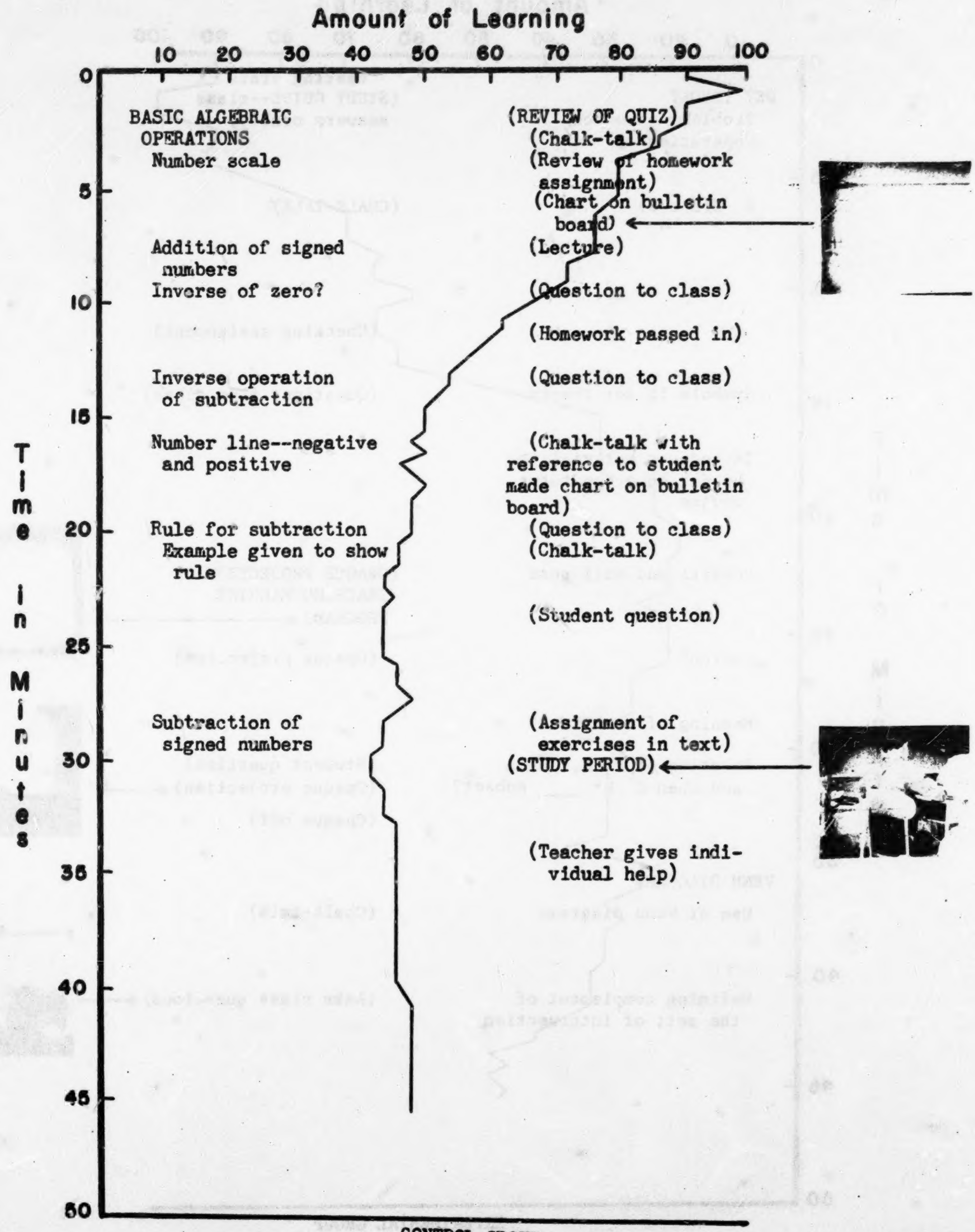
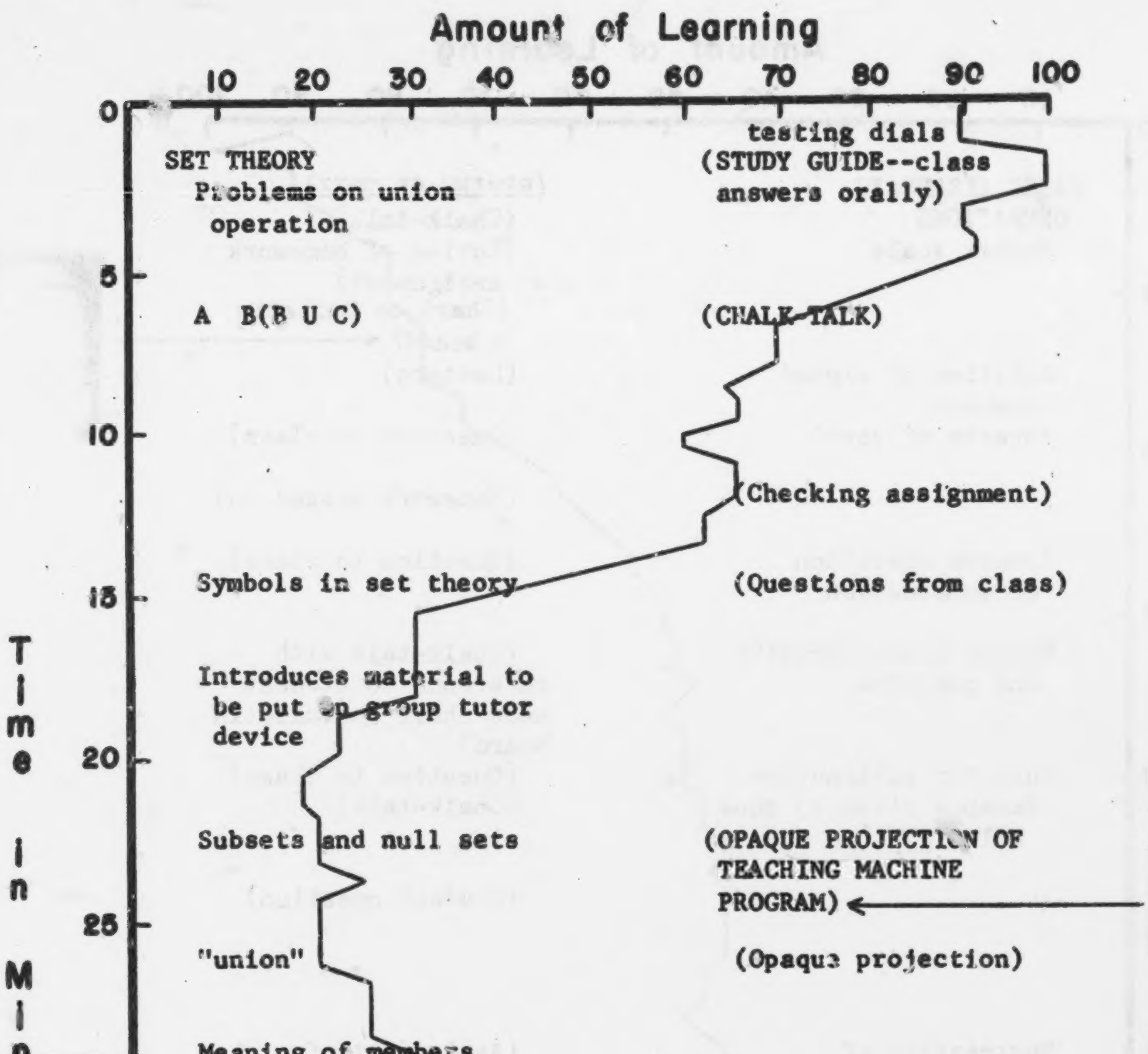
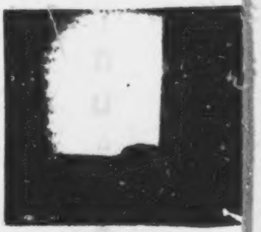


CONTROL GROUP

LEARNING PROFILE NUMBER 11





EXPERIMENTAL GROUP

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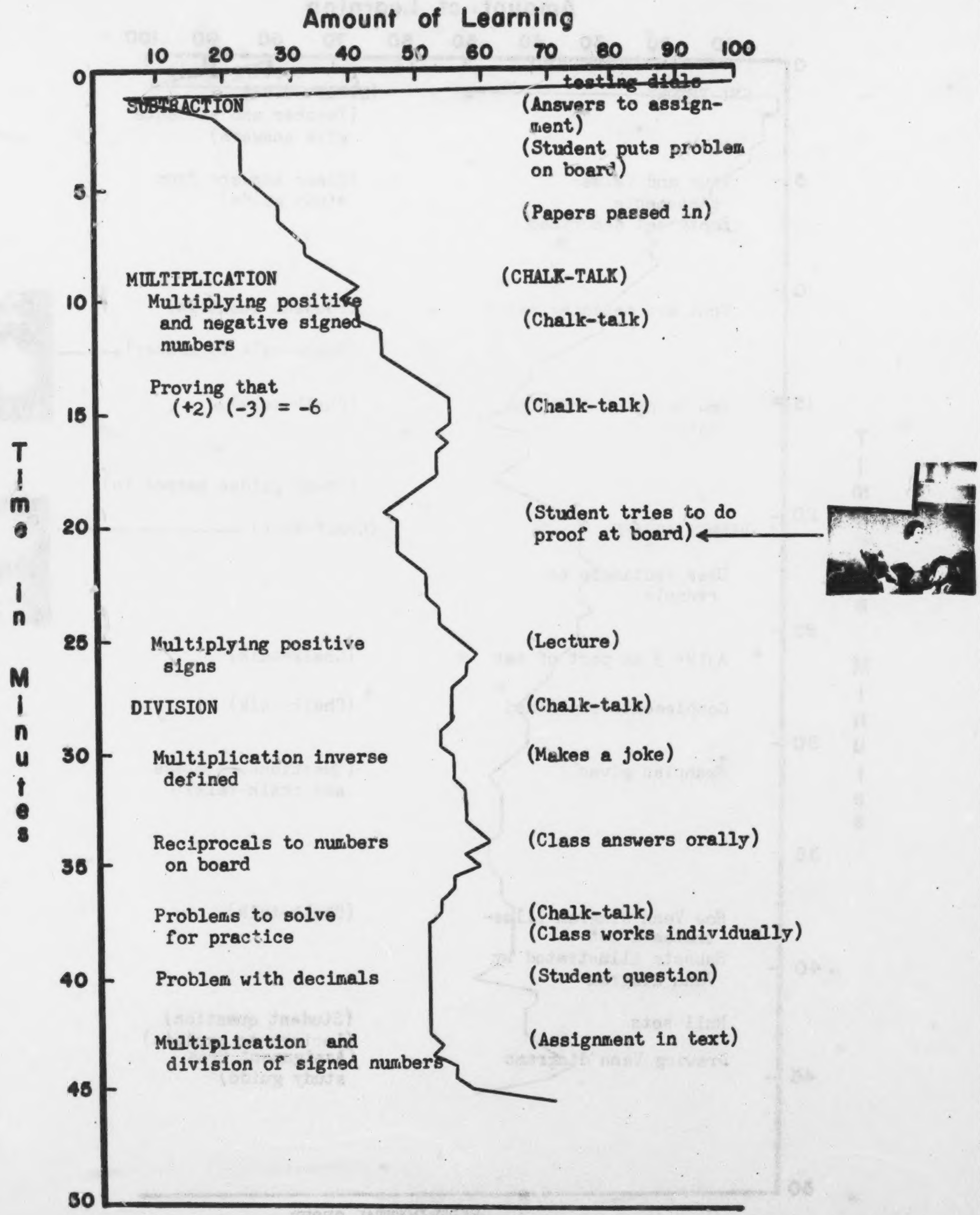
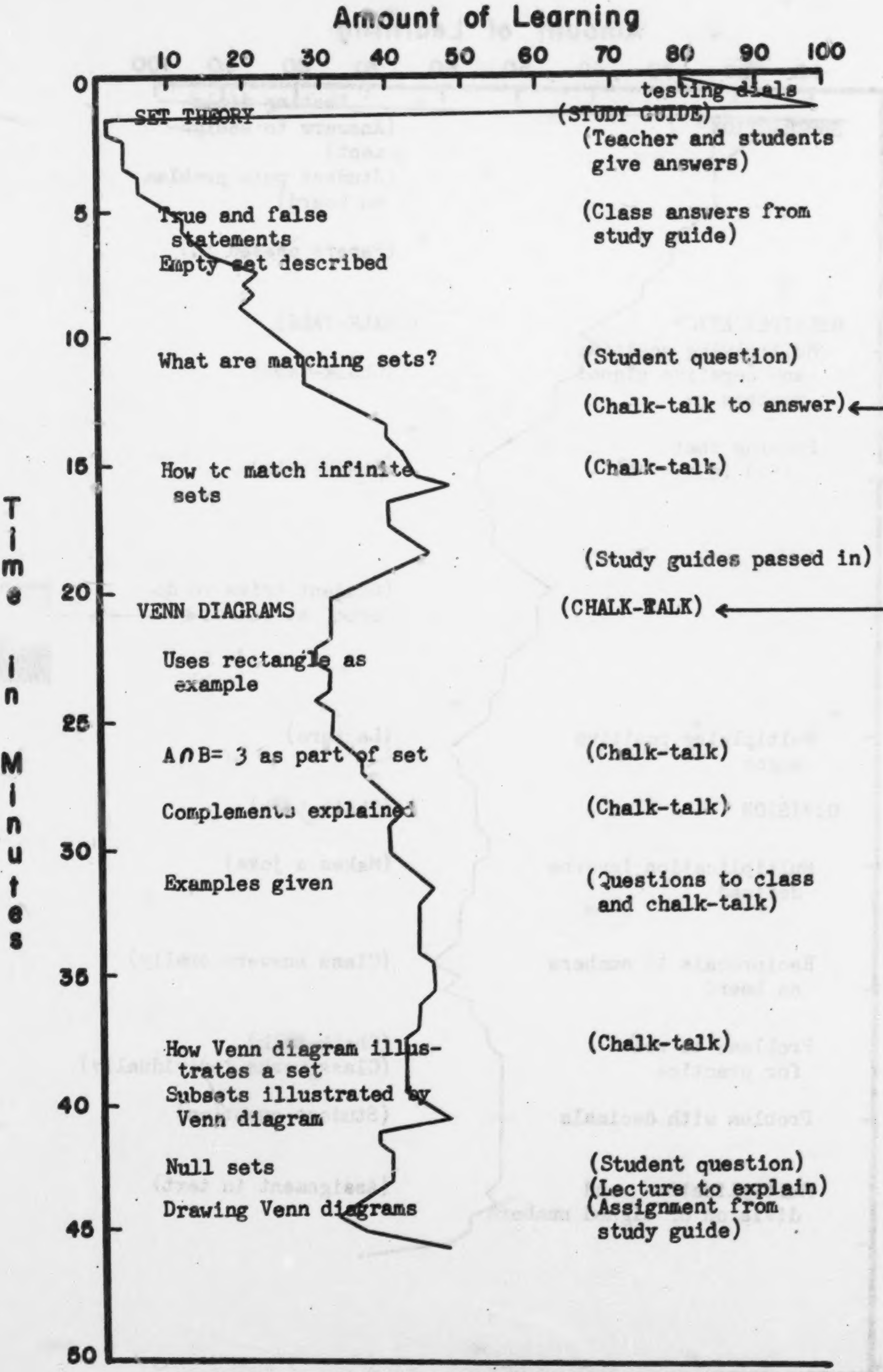


CON TROL GROUP

LEARNING PROFILE NUMBER 13



EXPERIMENTAL GROUP

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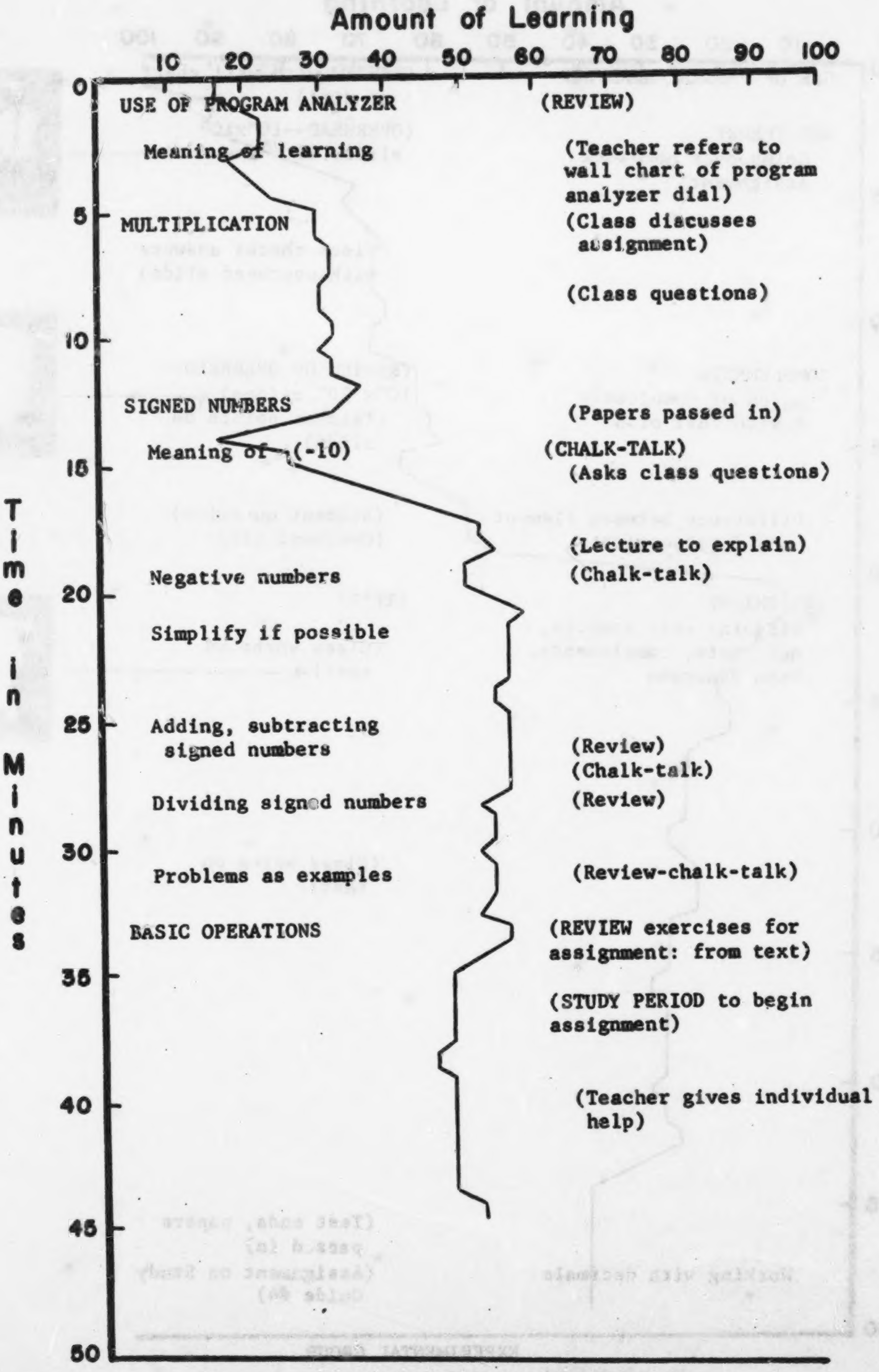

CONTROL GROUP

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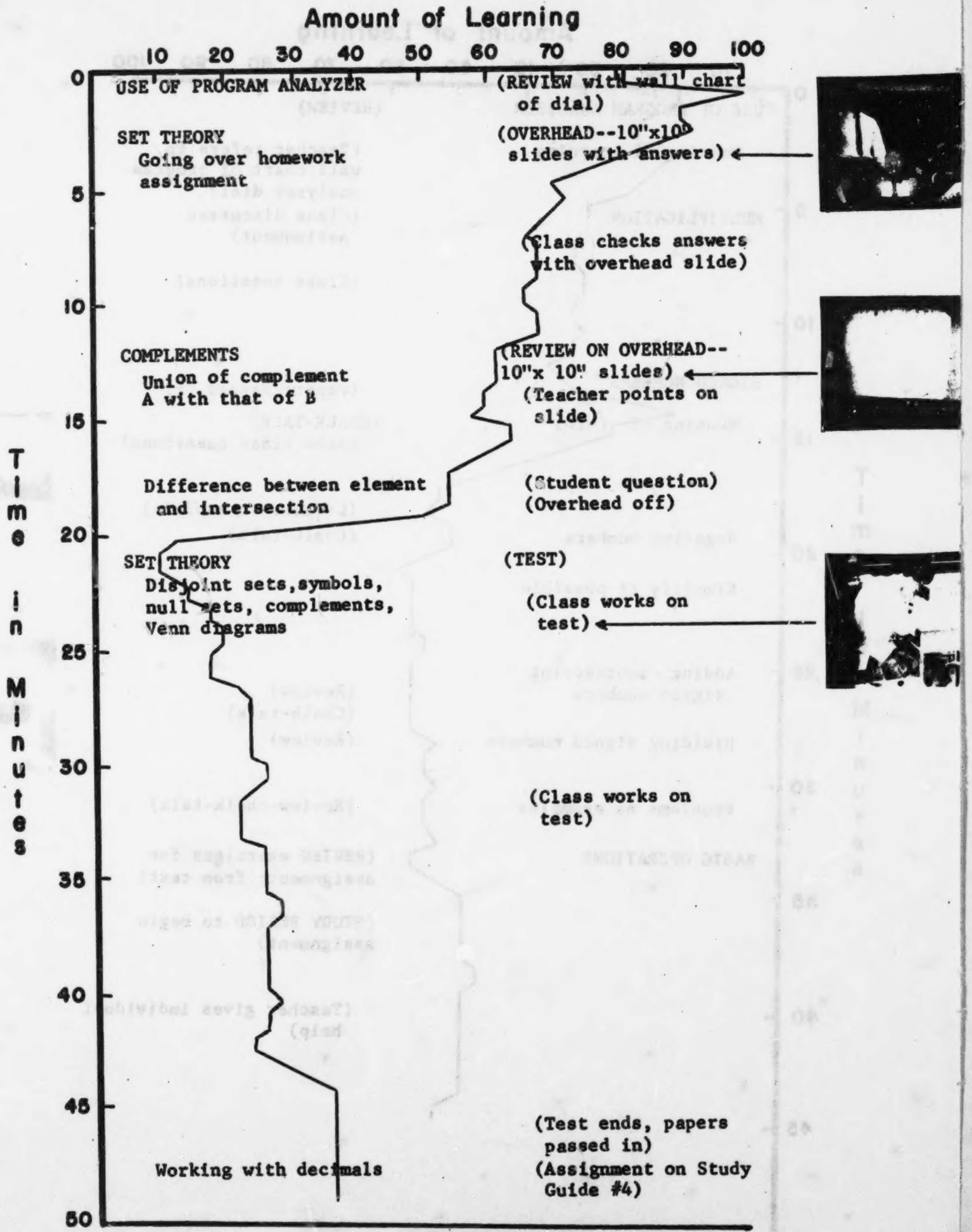

EXPERIMENTAL GROUP

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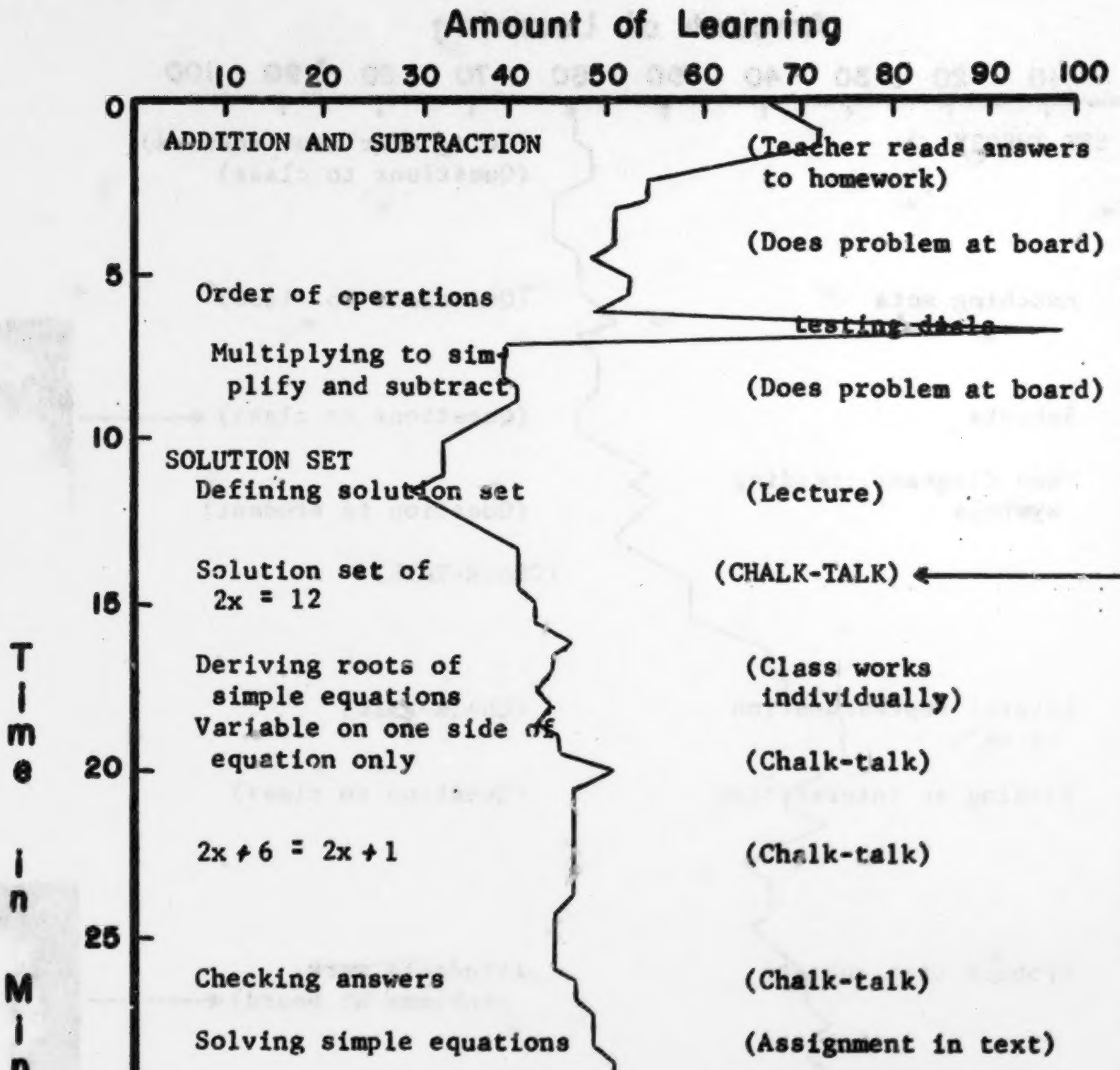

CONTROL GROUP

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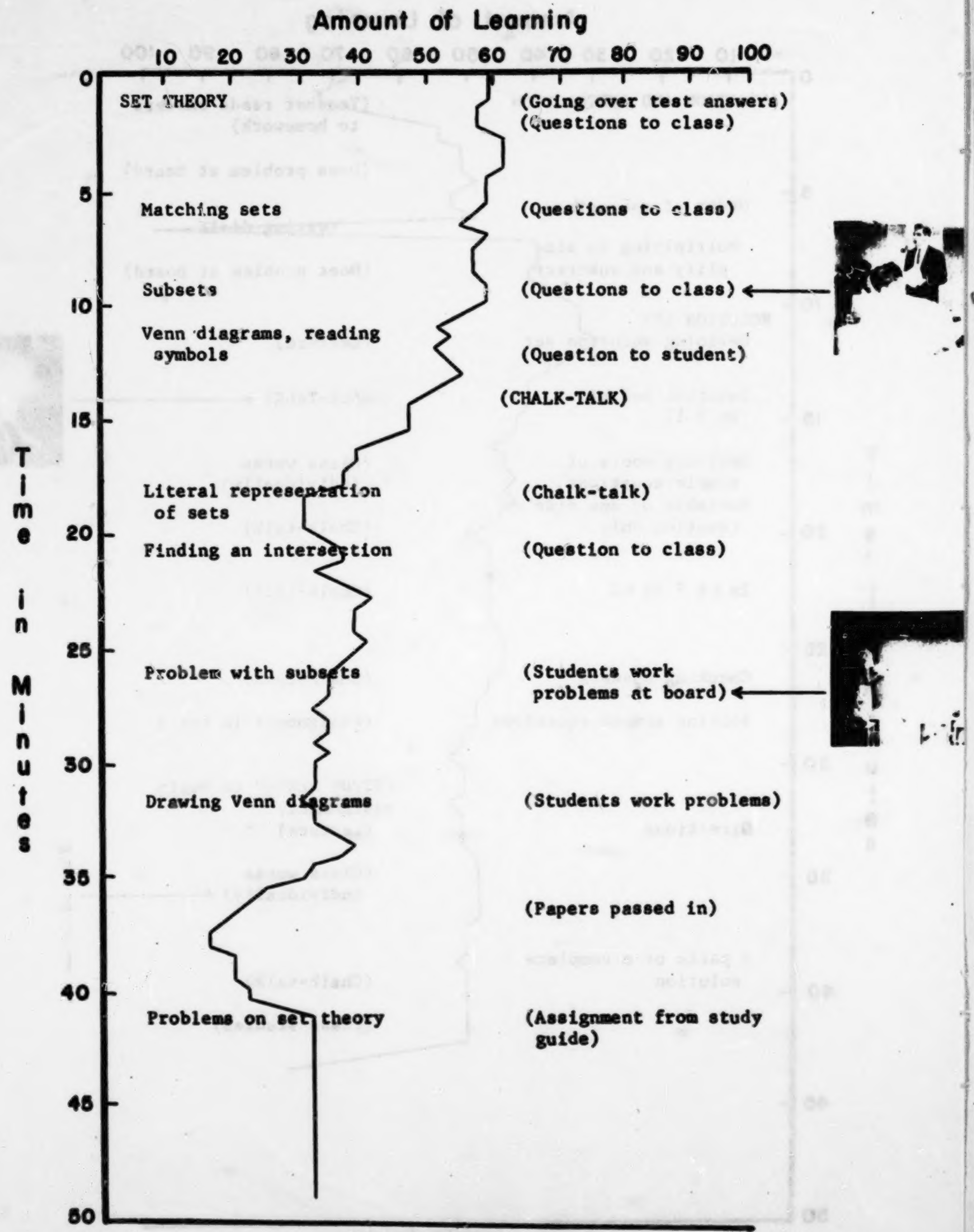

EXPERIMENTAL GROUP

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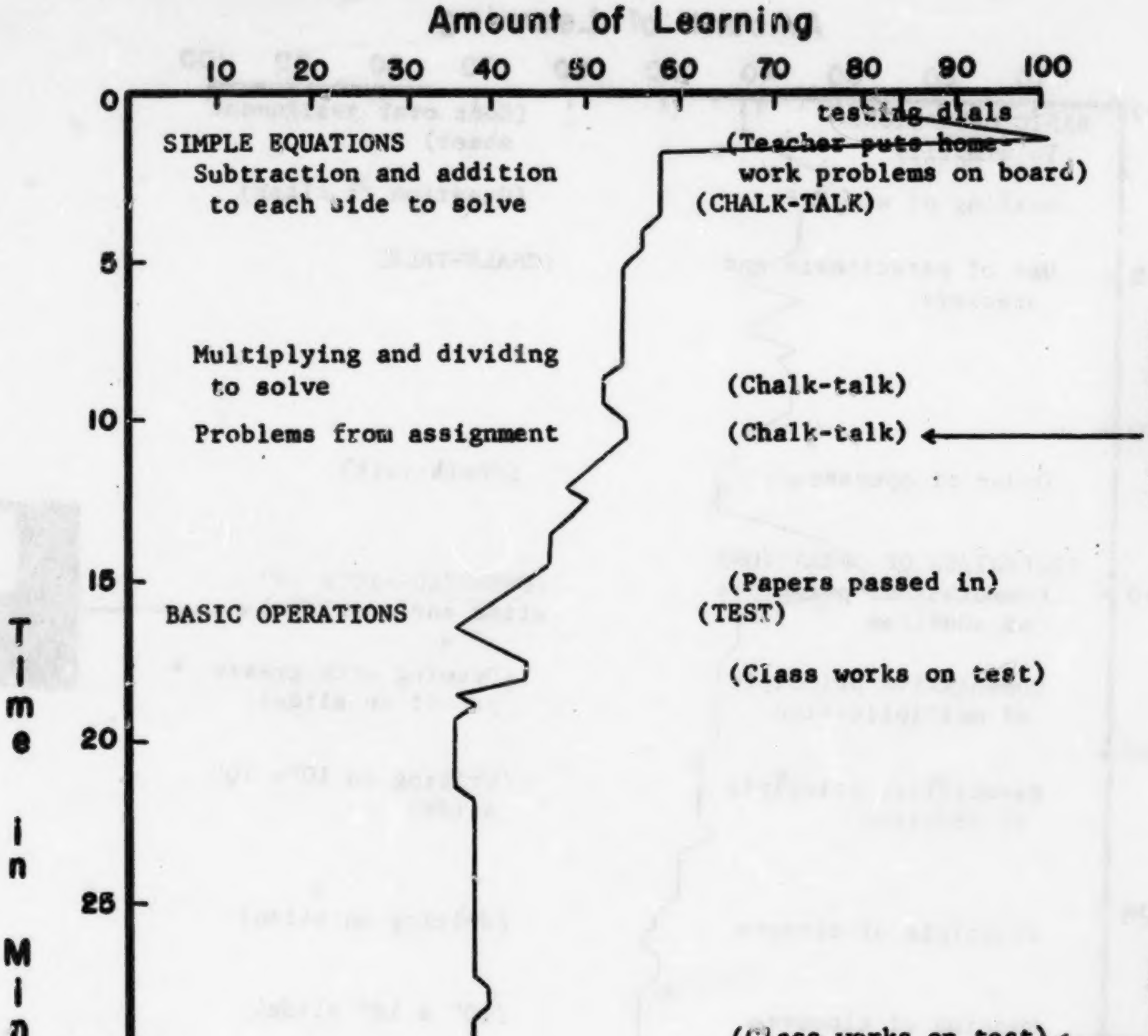
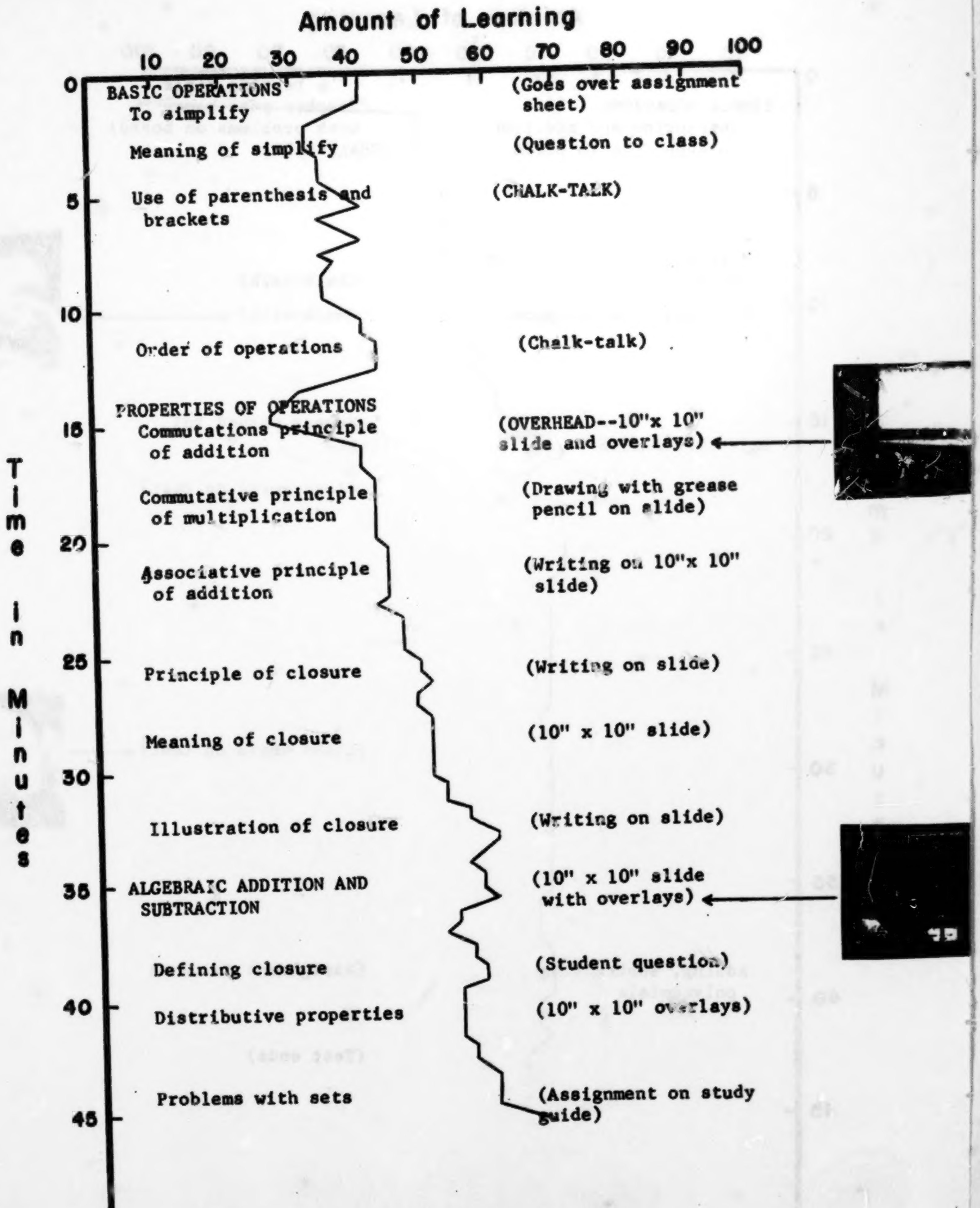


CONTROL GROUP

LEARNING PROFILE NUMBER 19



EXPERIMENTAL GROUP

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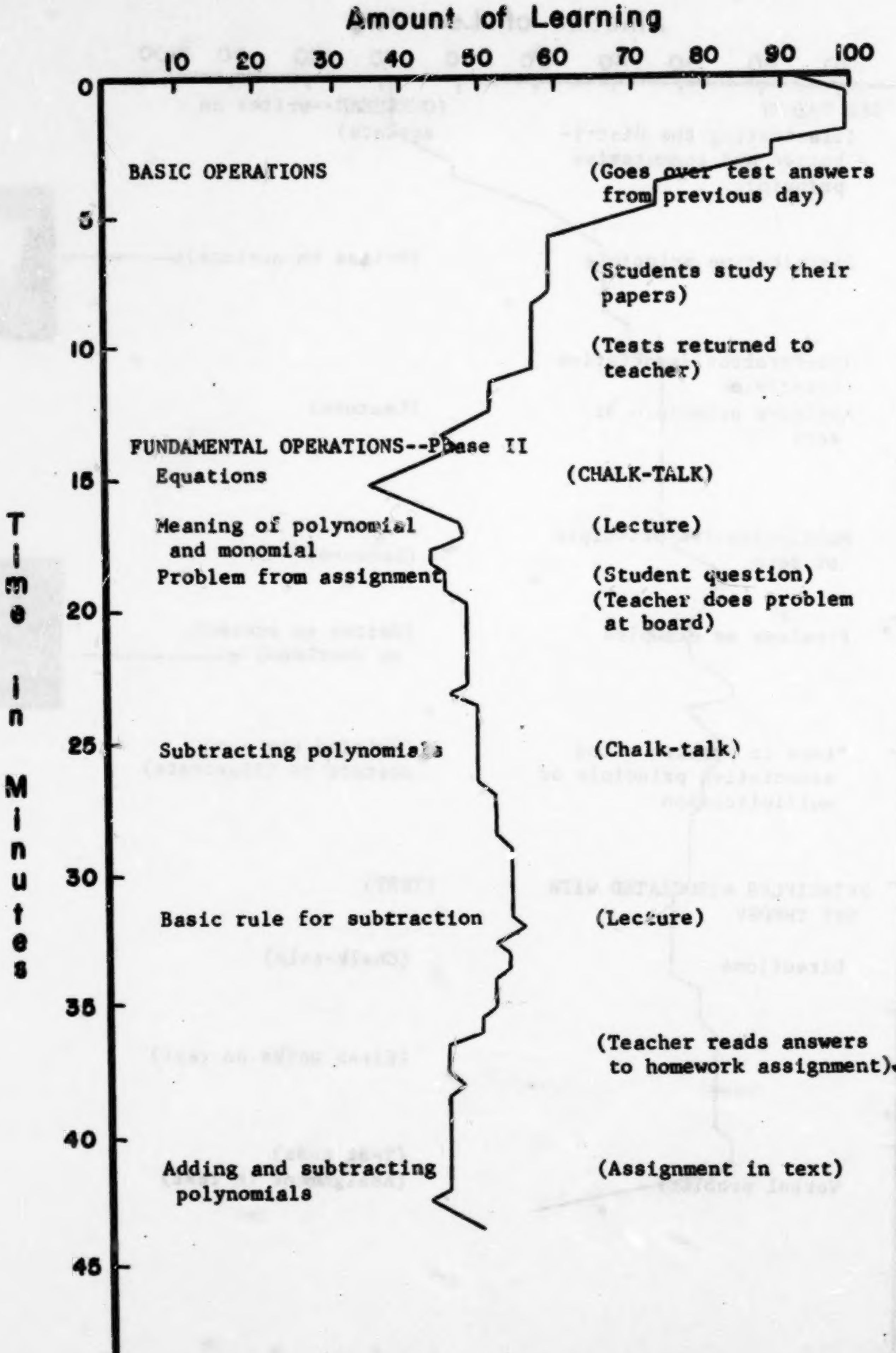
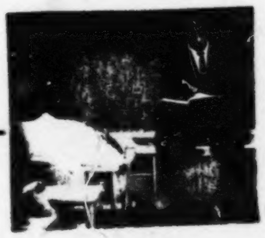
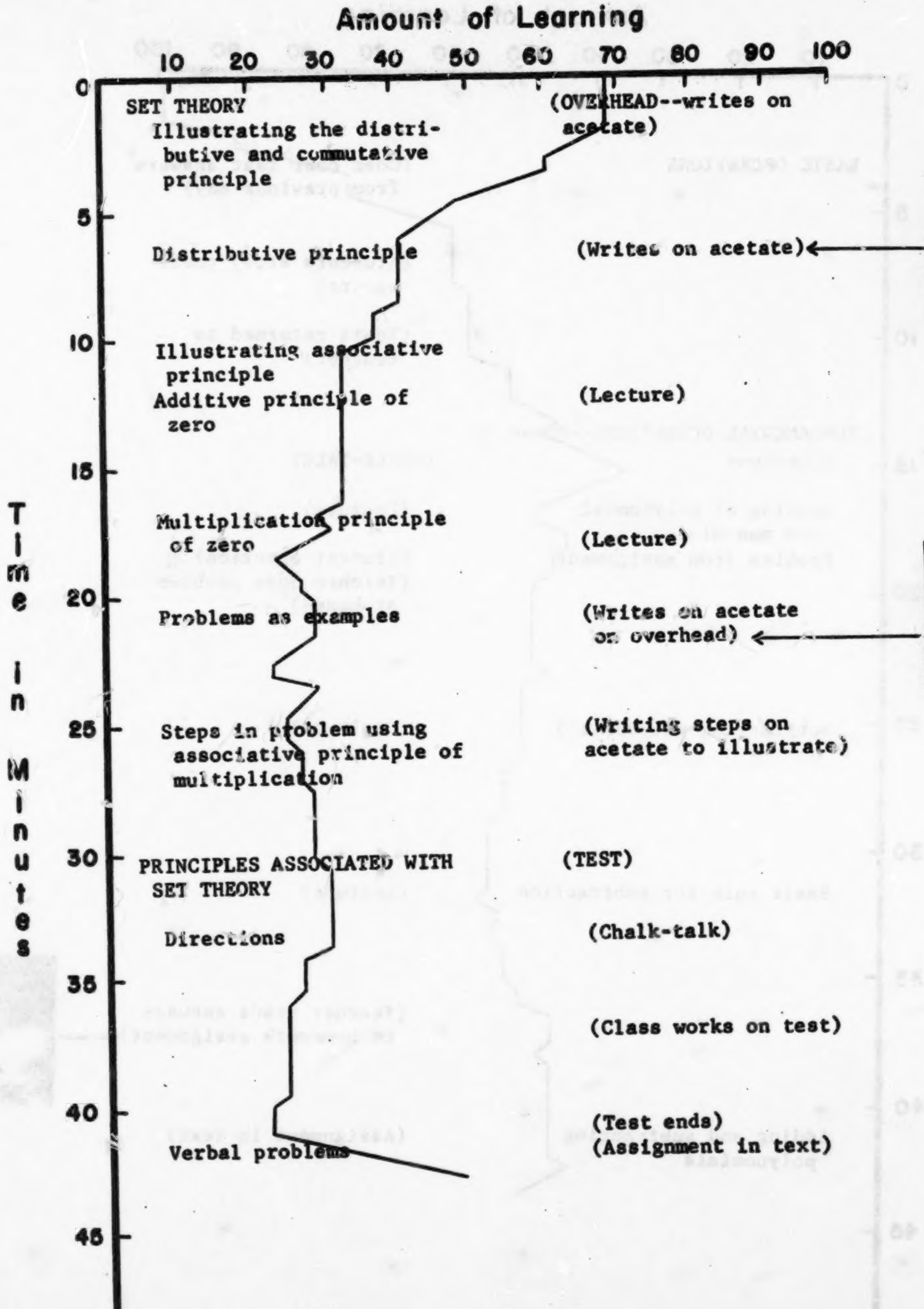
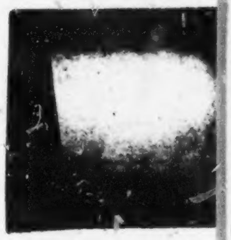




CONTROL GROUP

LEARNING PROFILE NUMBER 21





EXPERIMENTAL GROUP

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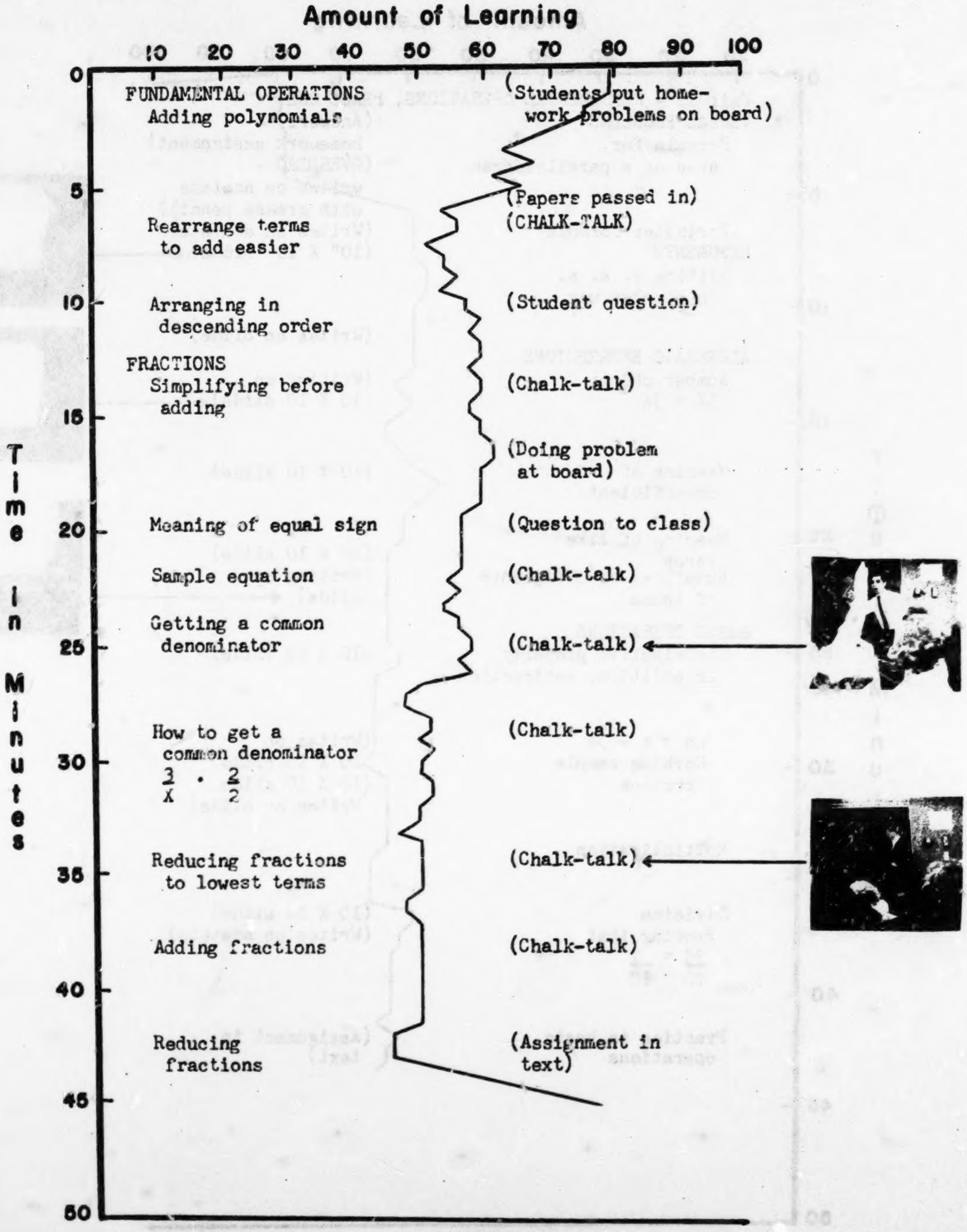
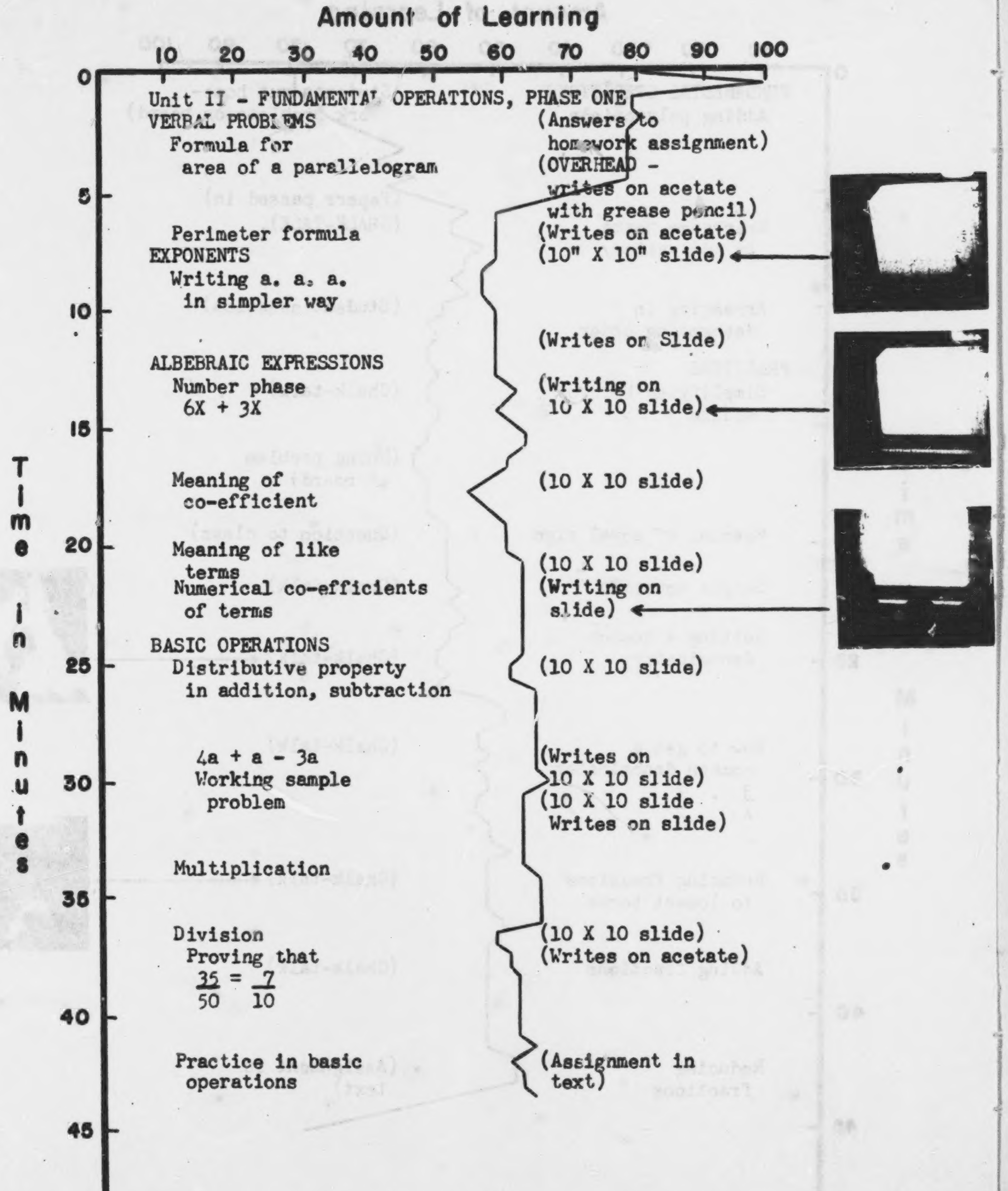


CONTROL GROUP

LEARNING PROFILE NUMBER 23



EXPERIMENTAL GROUP

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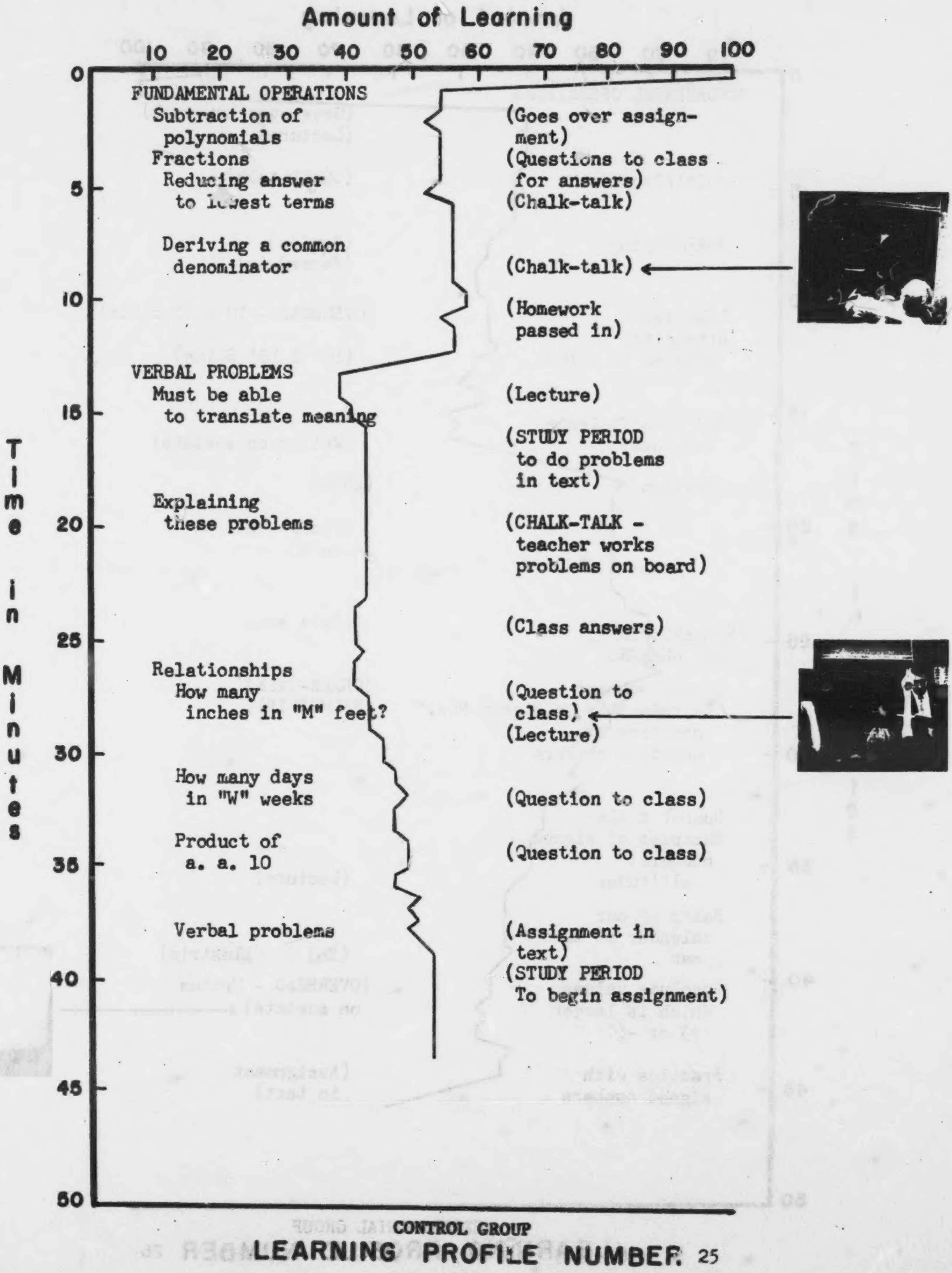
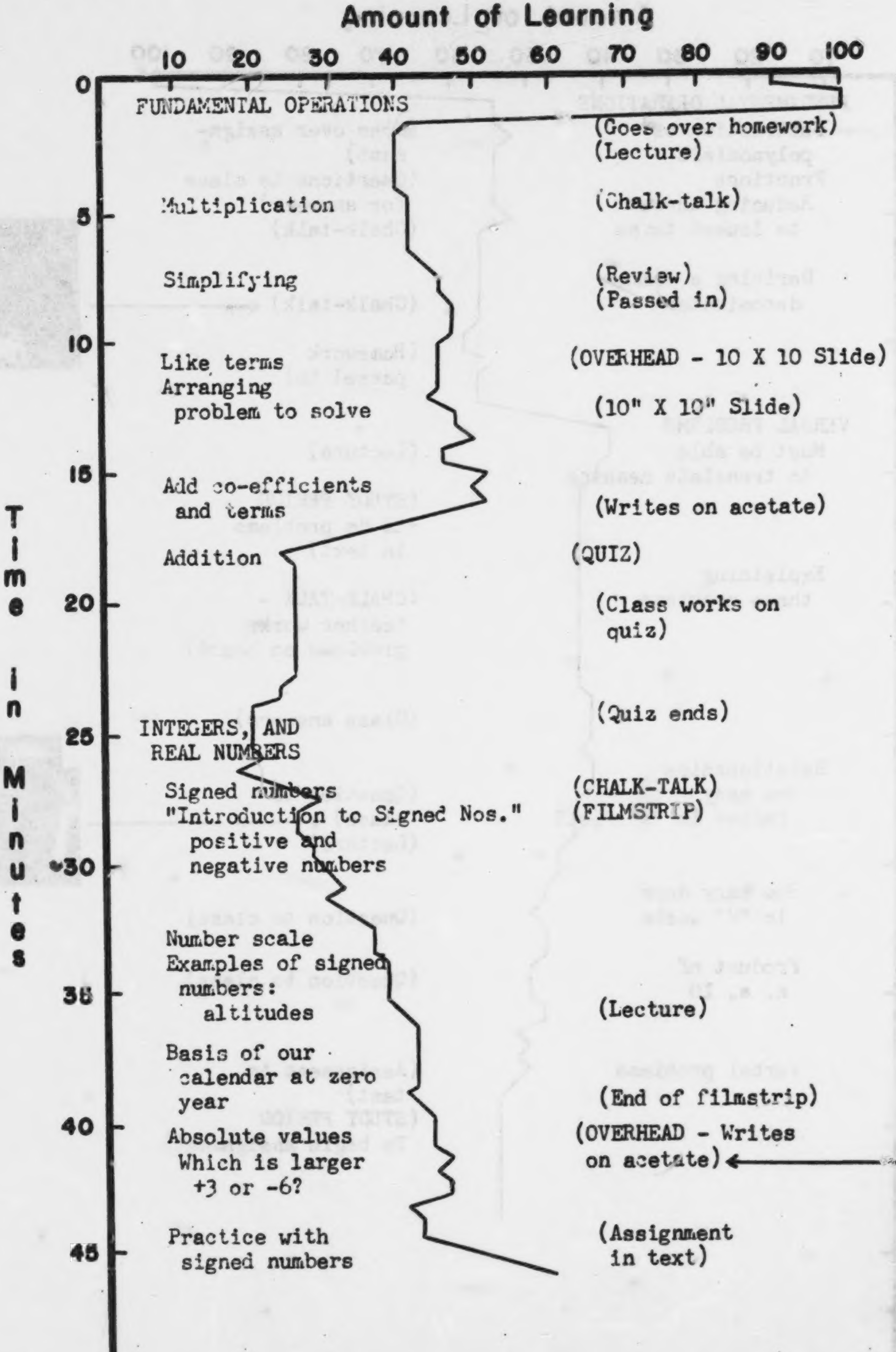


CONTROL GROUP

LEARNING PROFILE NUMBER 25



EXPERIMENTAL GROUP

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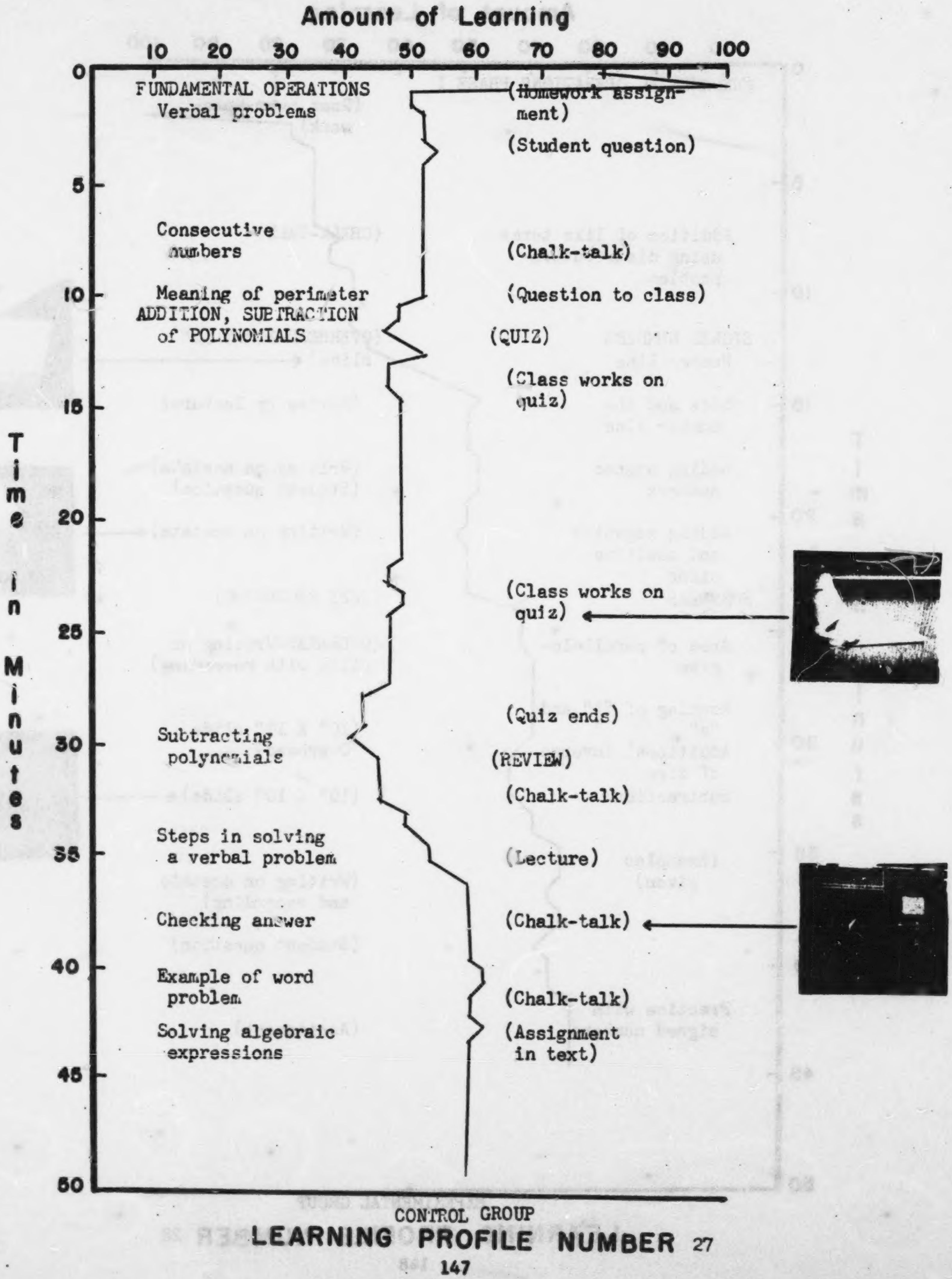
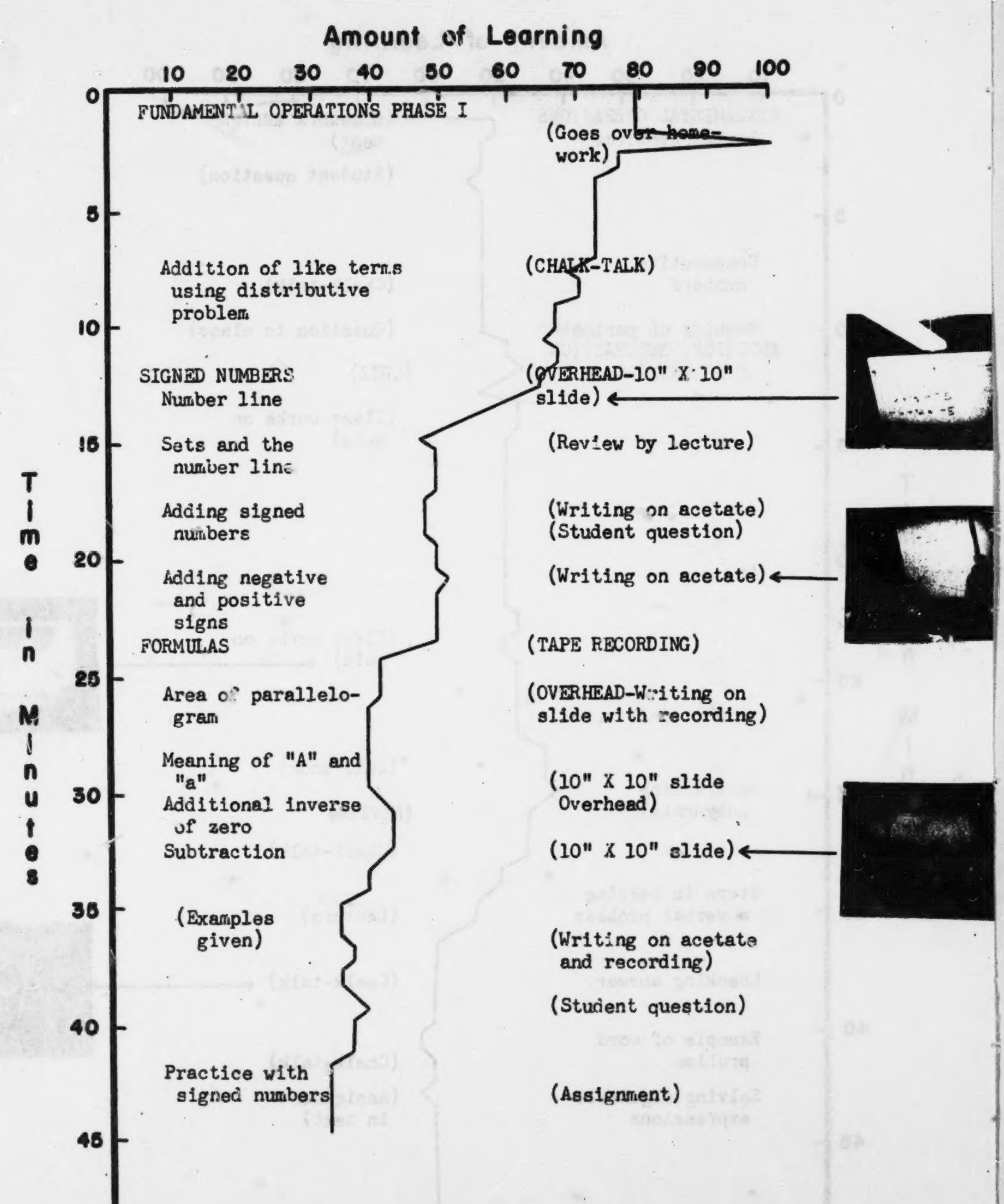


CONTROL GROUP

LEARNING PROFILE NUMBER 27



EXPERIMENTAL GROUP

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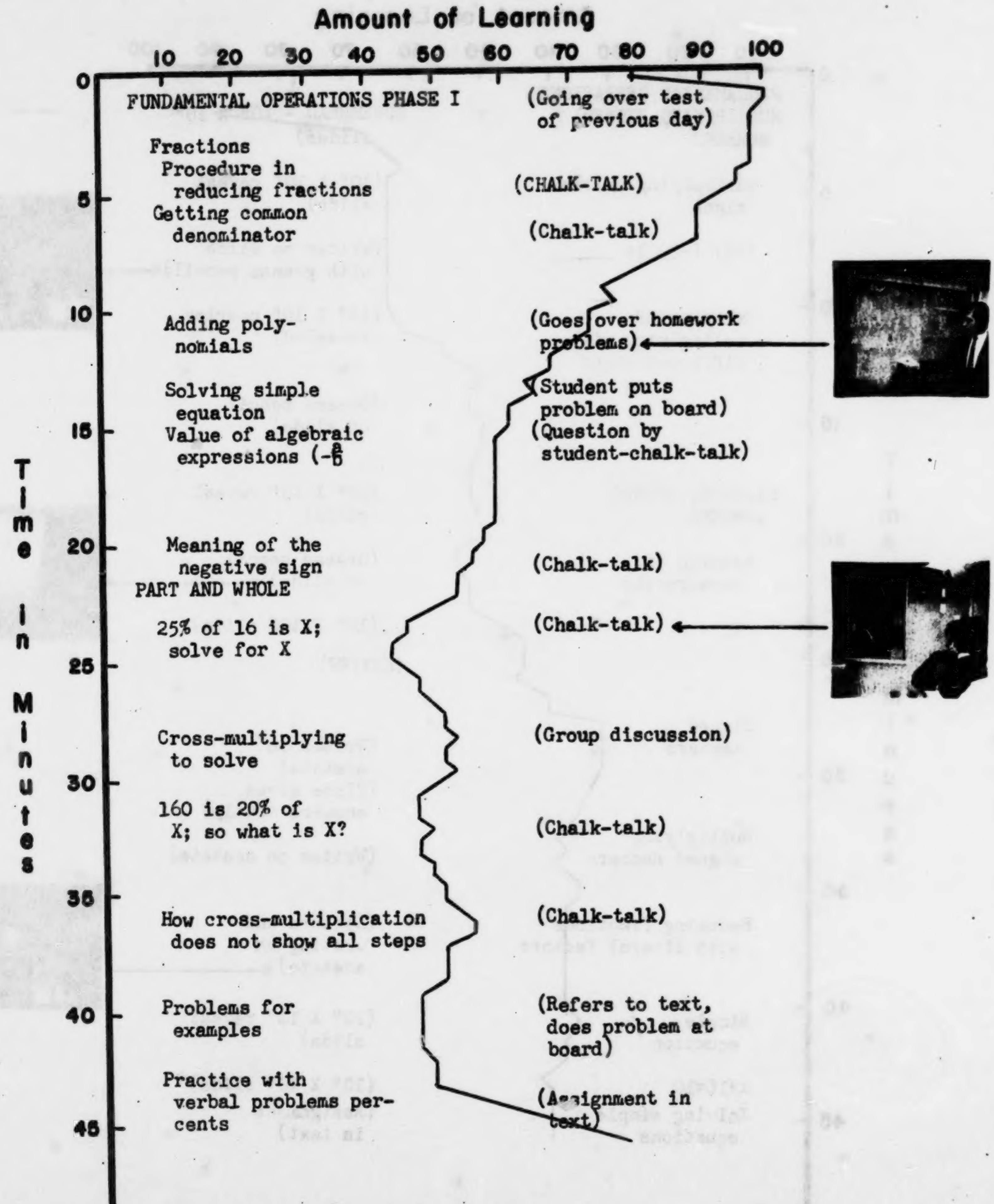
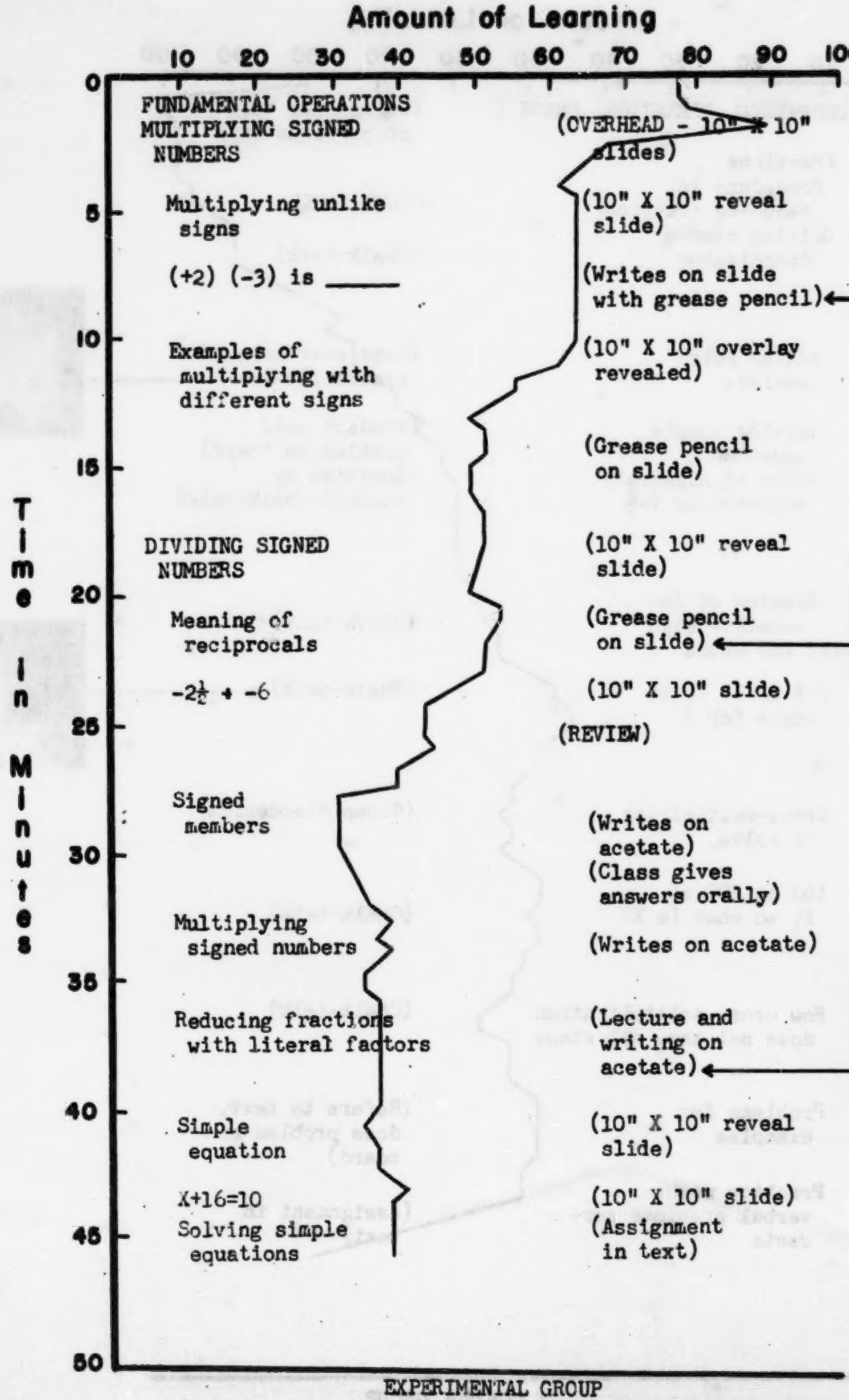


CONTROL GROUP

LEARNING PROFILE NUMBER 29



EXPERIMENTAL GROUP

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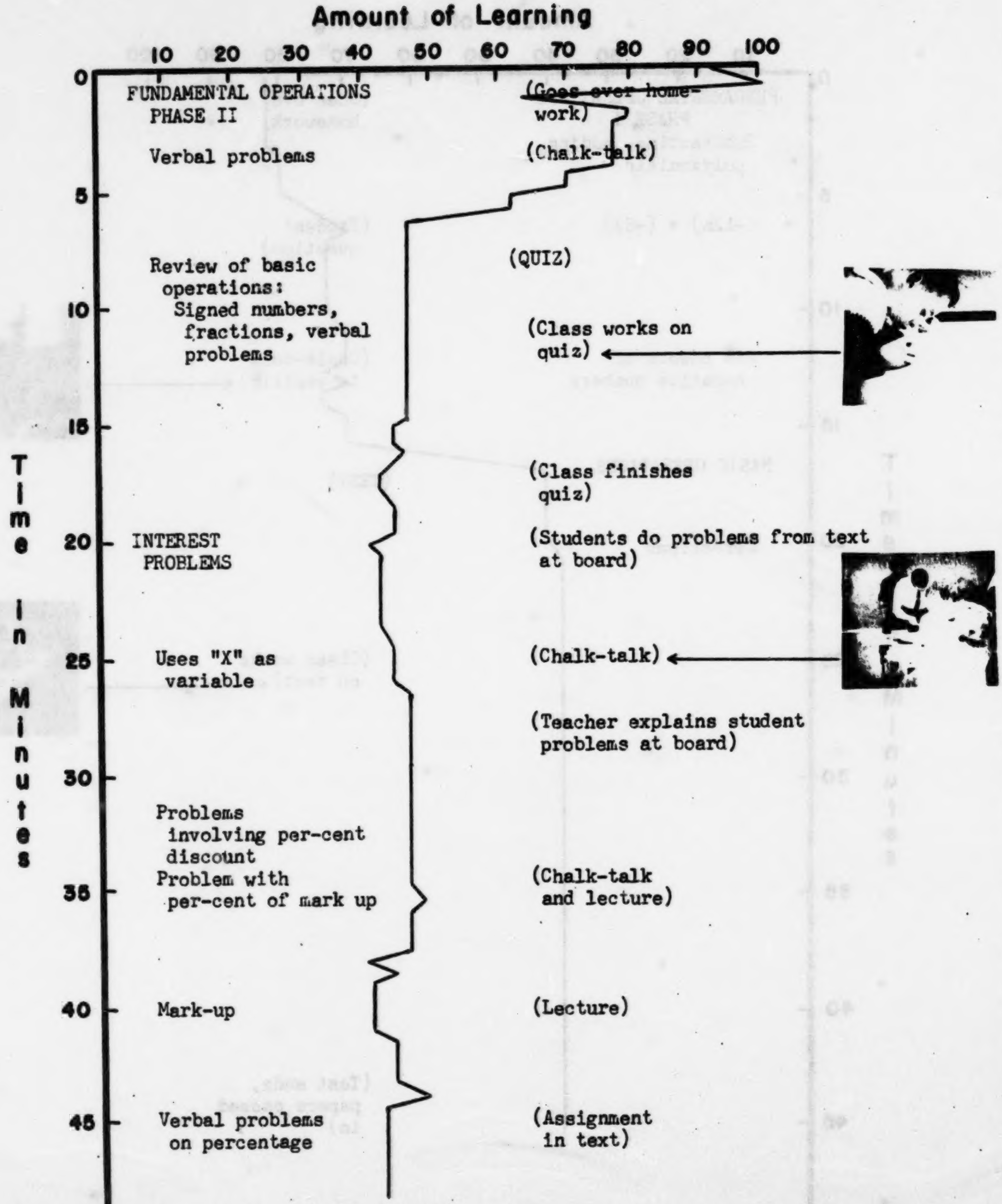
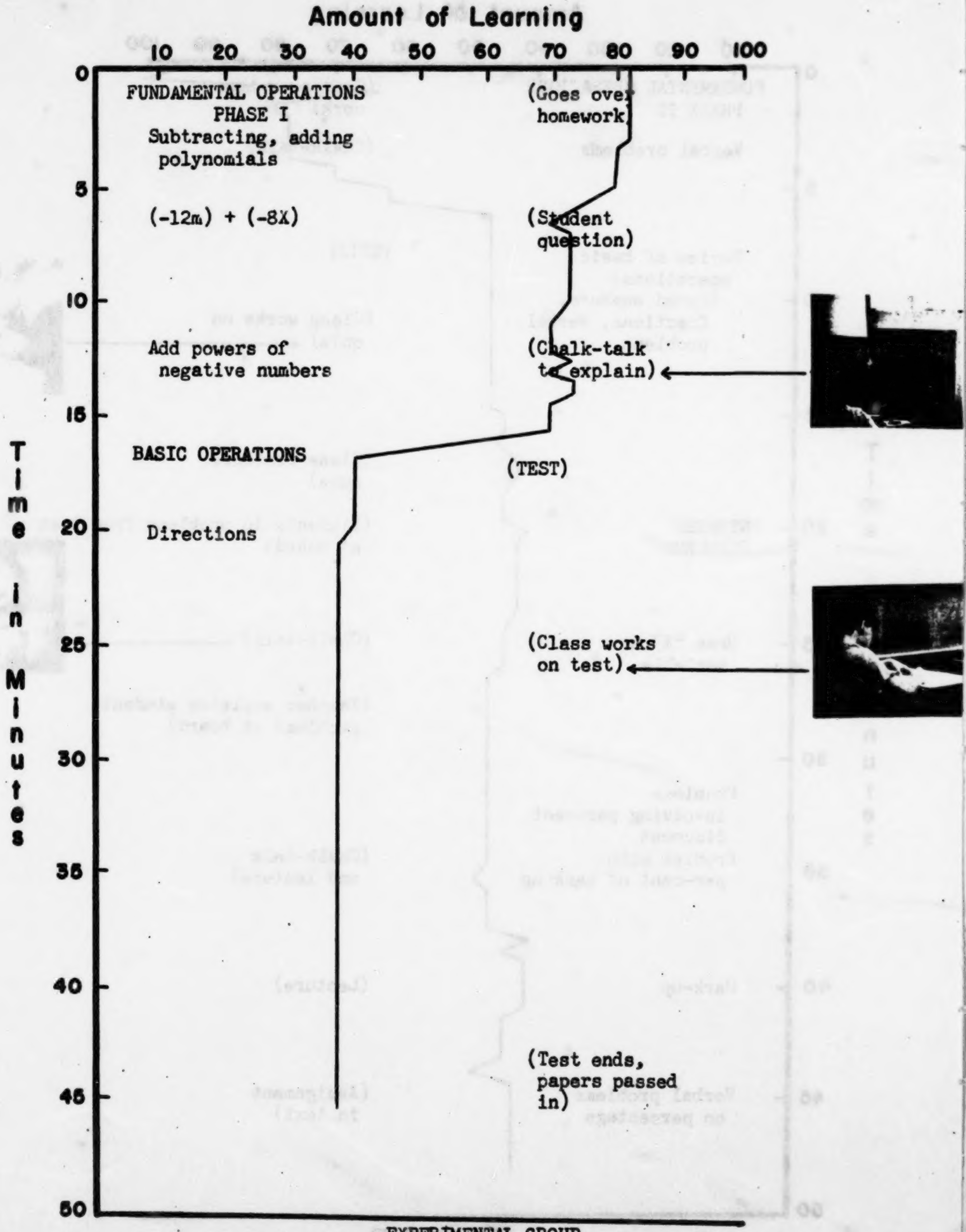


CONTROL GROUP

LEARNING PROFILE NUMBER 31



EXPERIMENTAL GROUP

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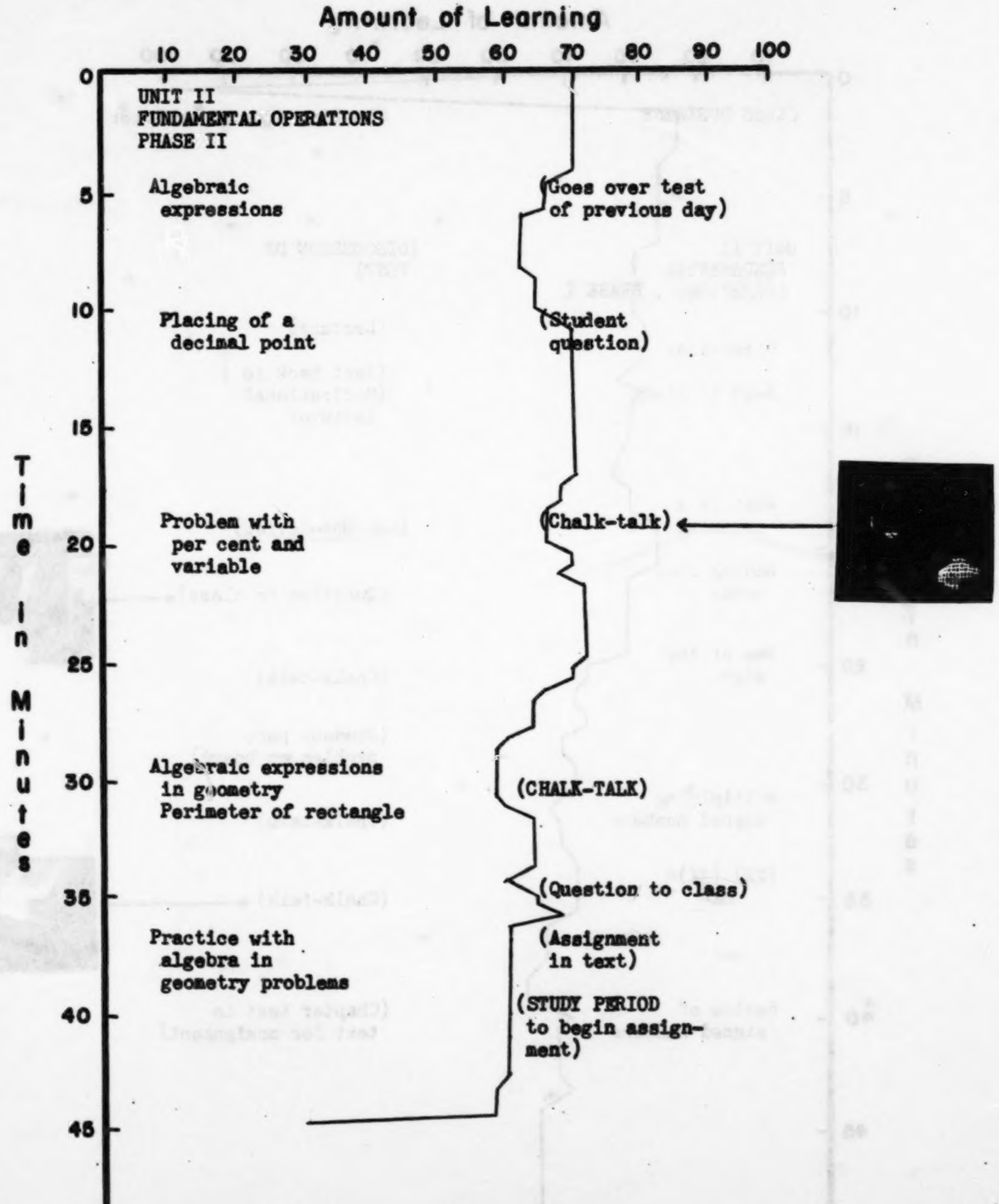

CONTROL GROUP

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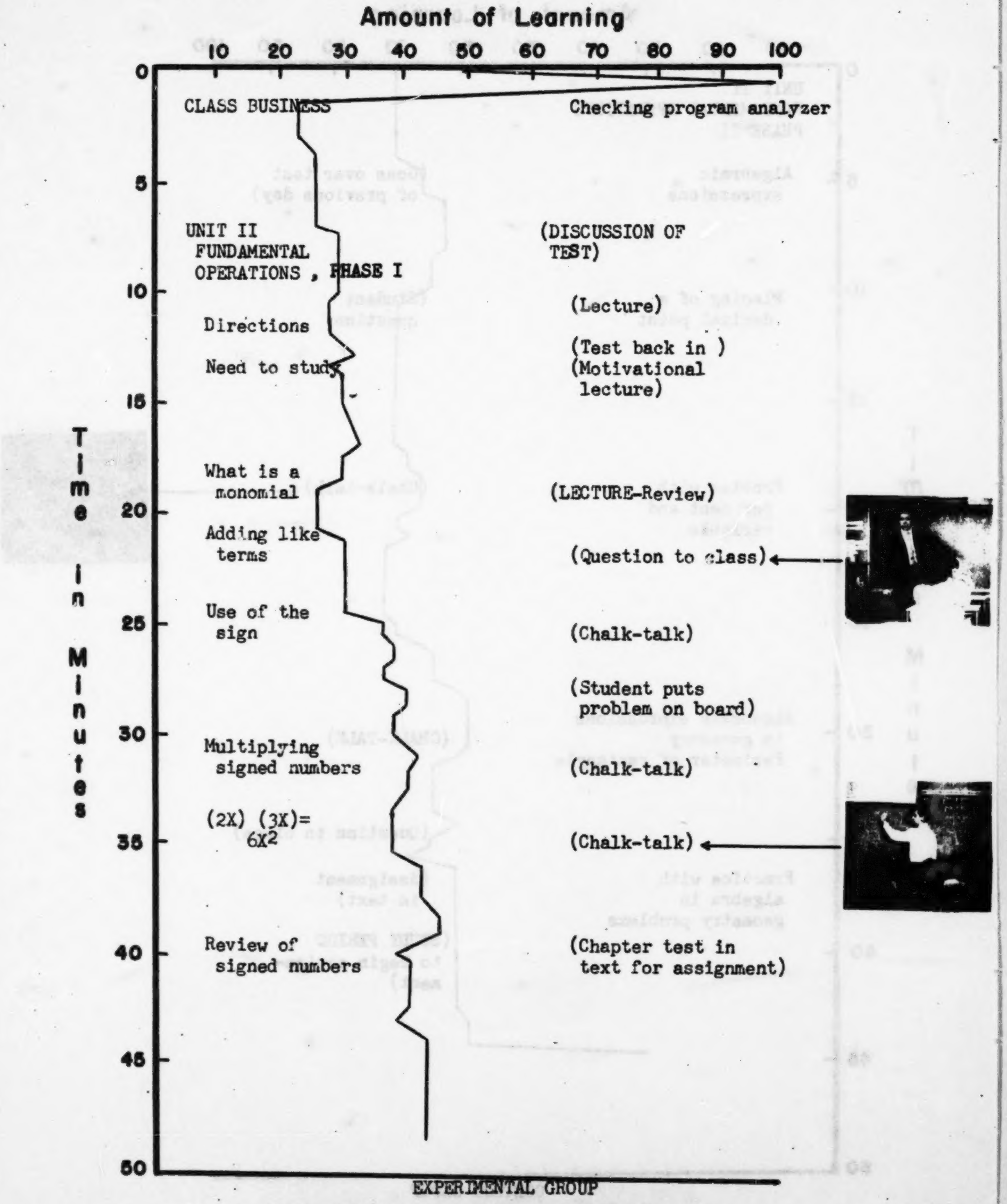

EXPERIMENTAL GROUP

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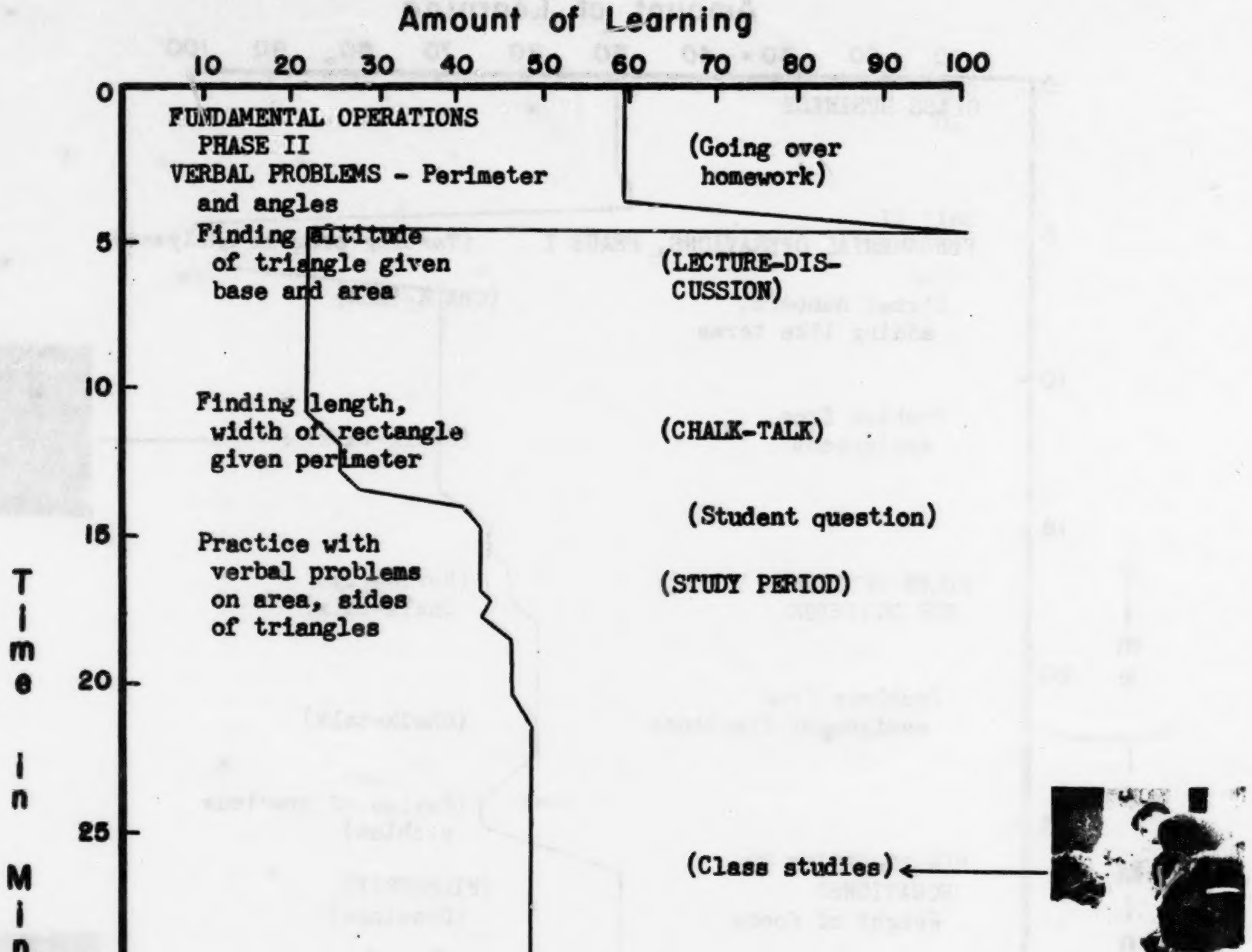
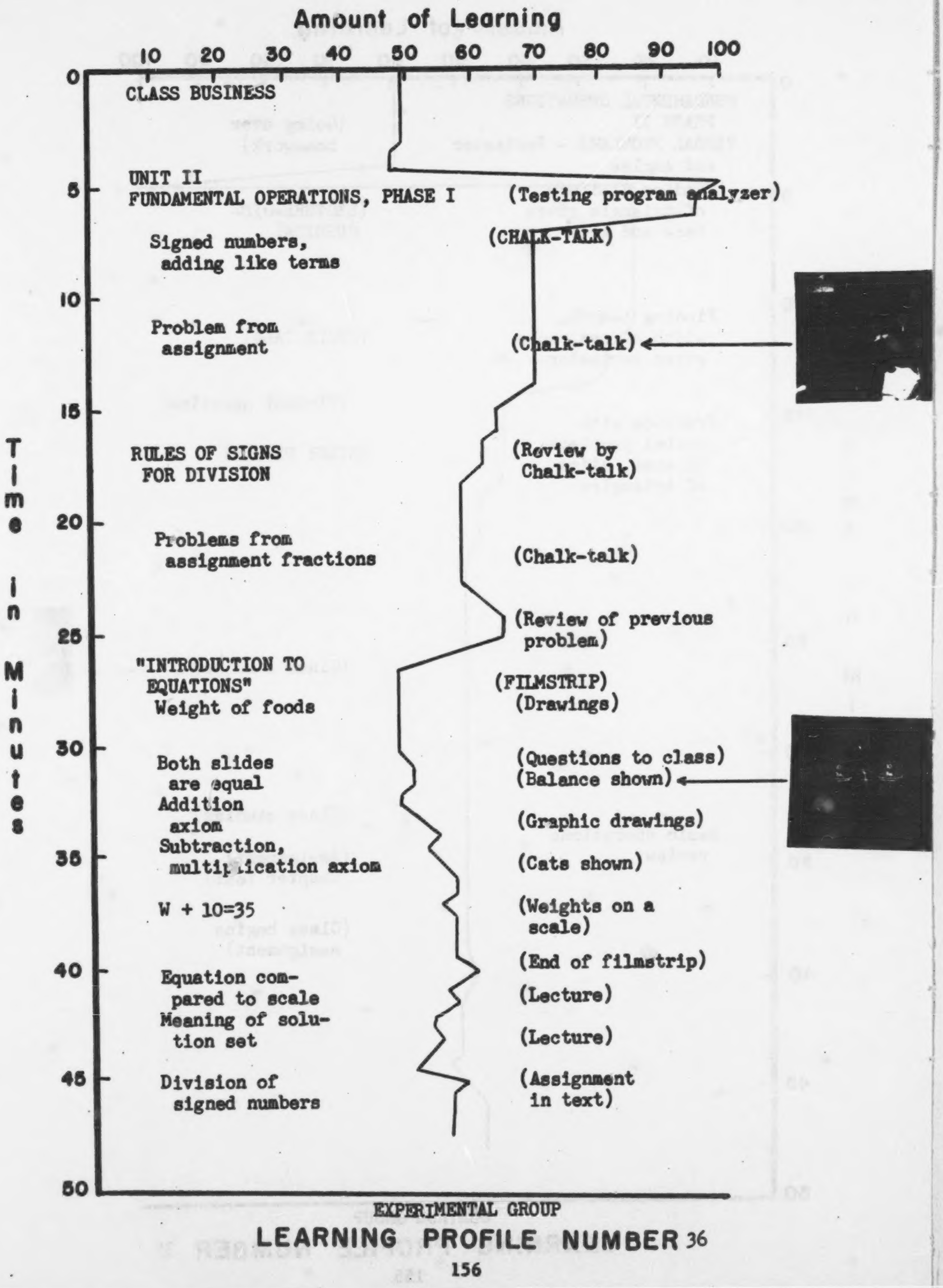


CONTROL GROUP

LEARNING PROFILE NUMBER 35



EXPERIMENTAL GROUP

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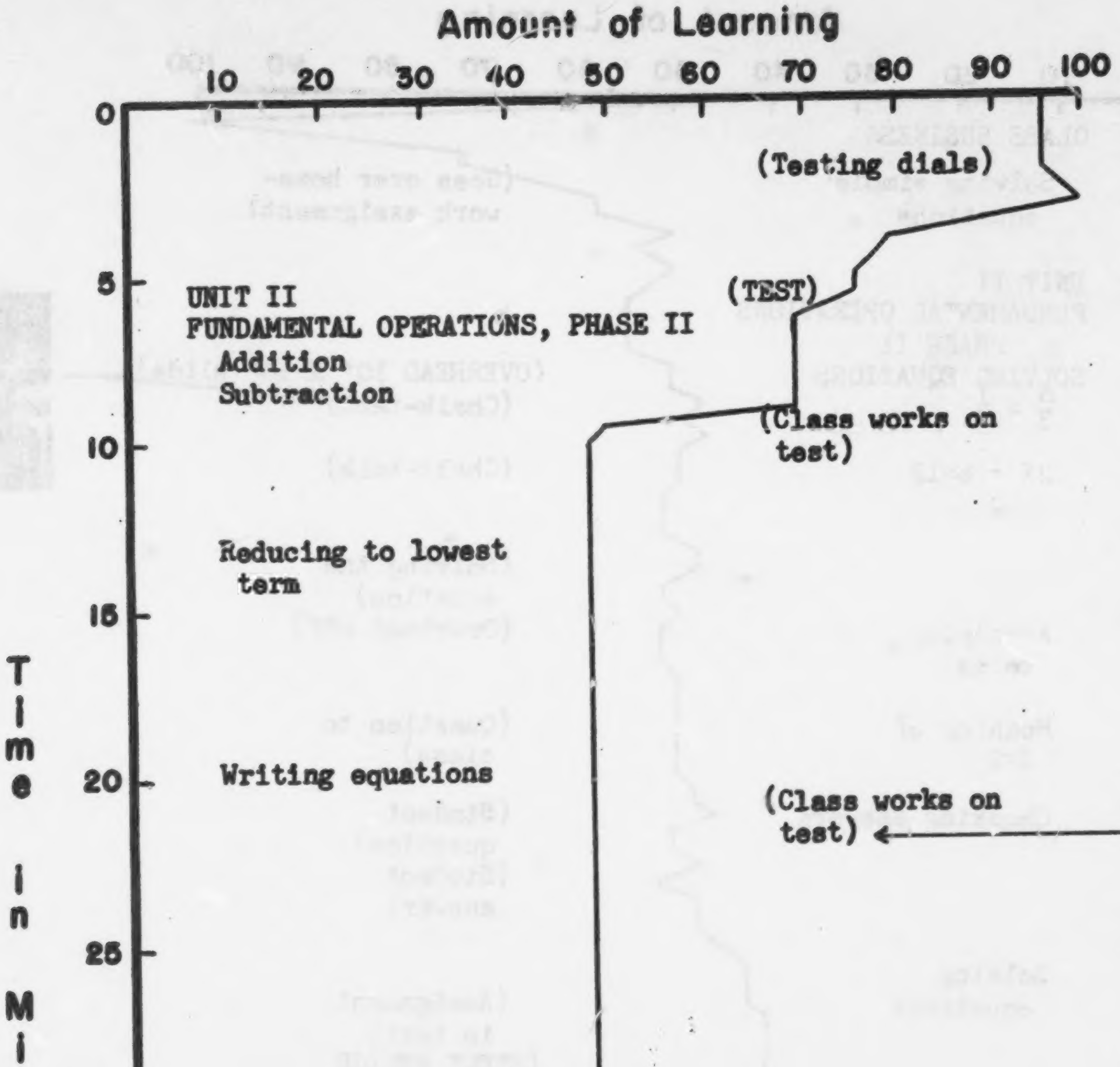

CONTROL GROUP

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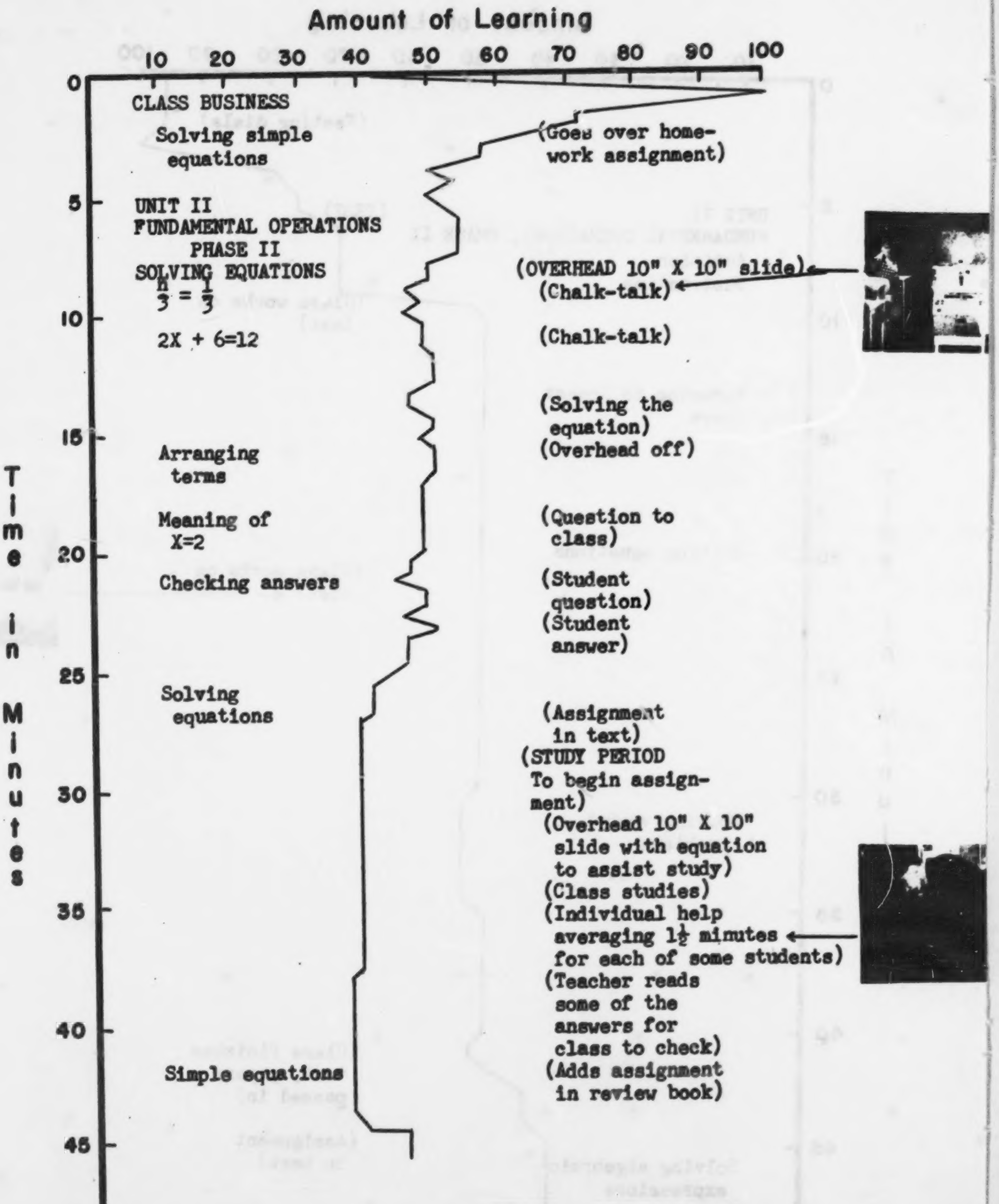

EXPERIMENTAL GROUP

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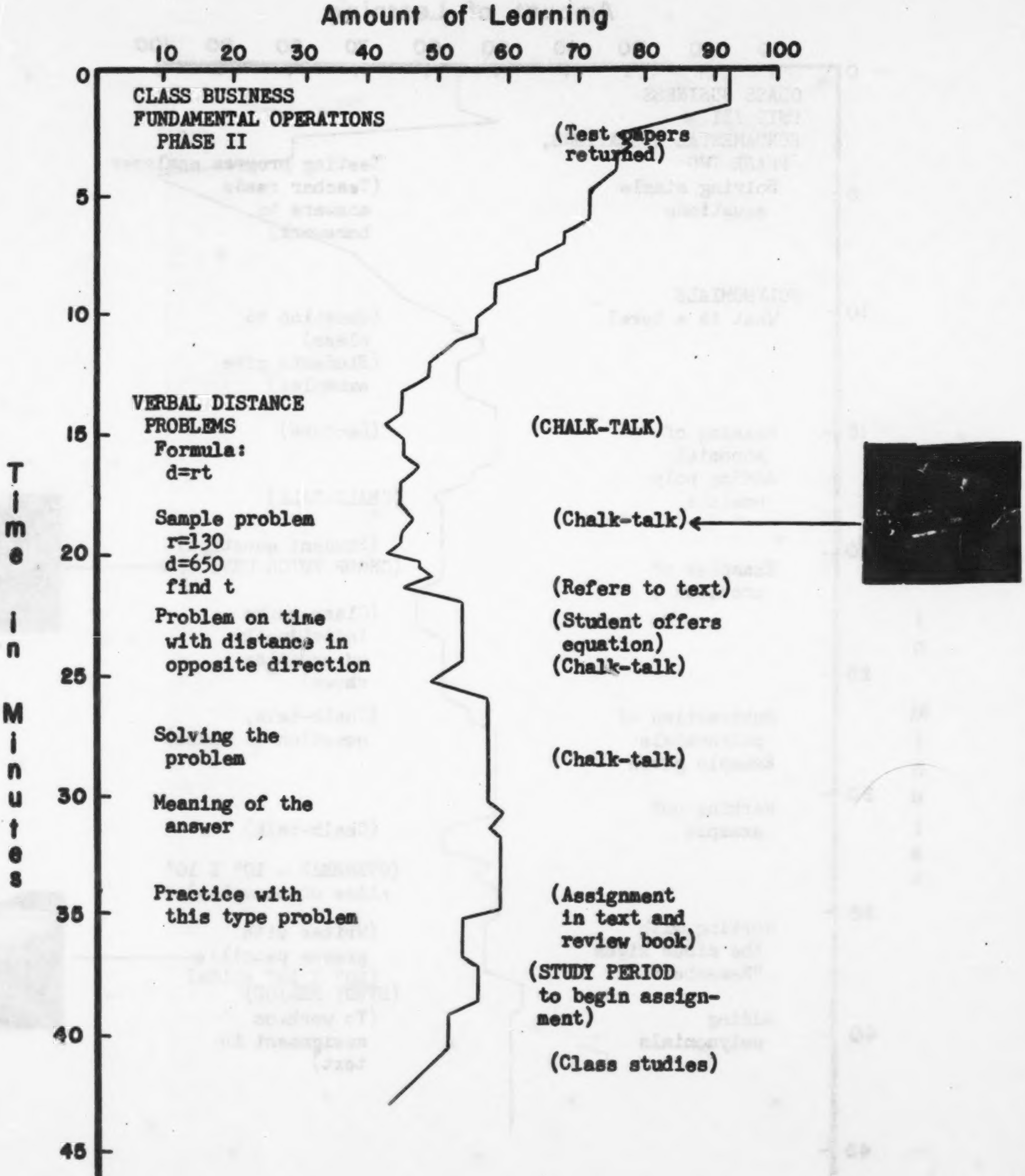
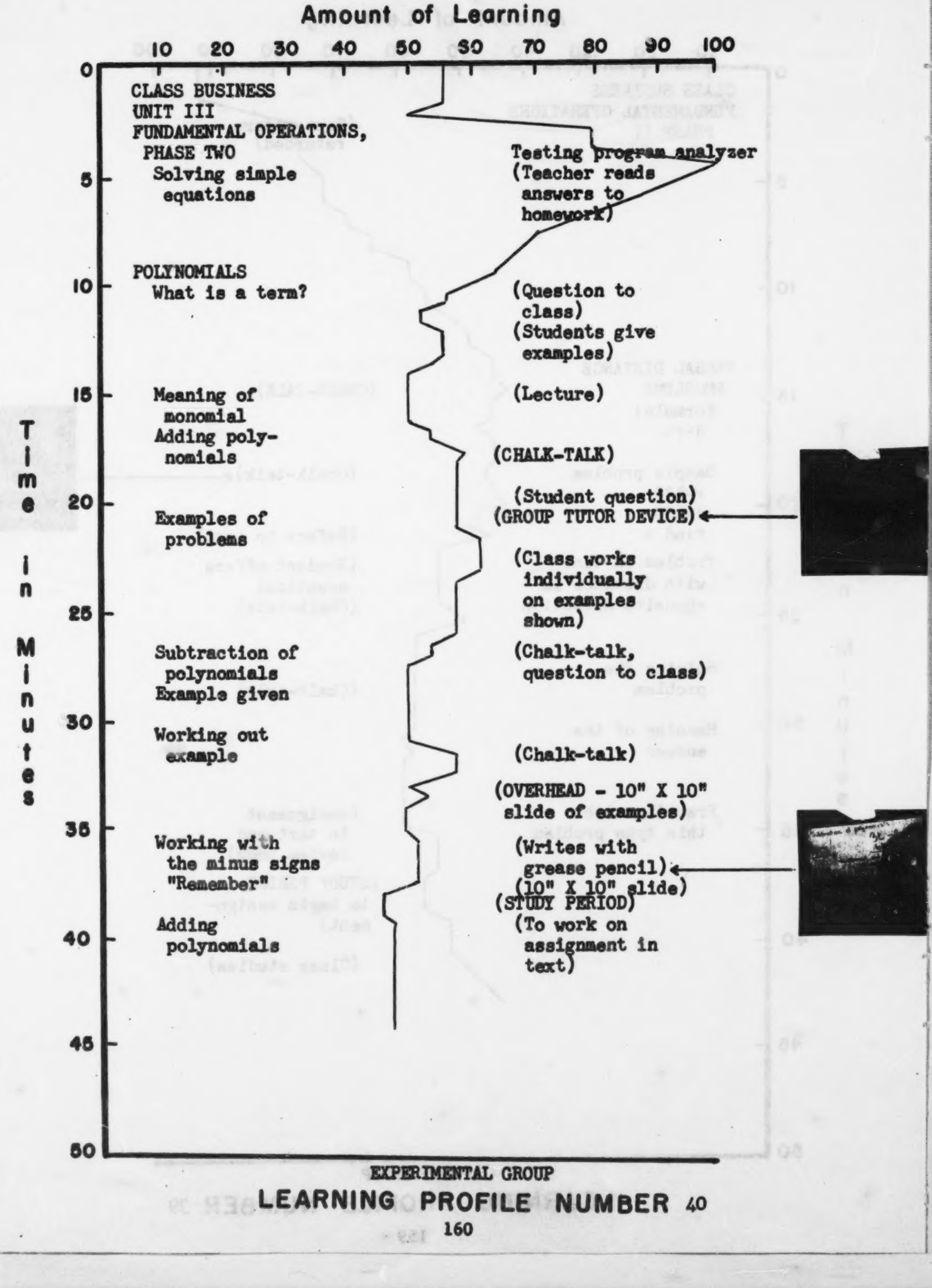


CONTROL GROUP

LEARNING PROFILE NUMBER 39



EXPERIMENTAL GROUP

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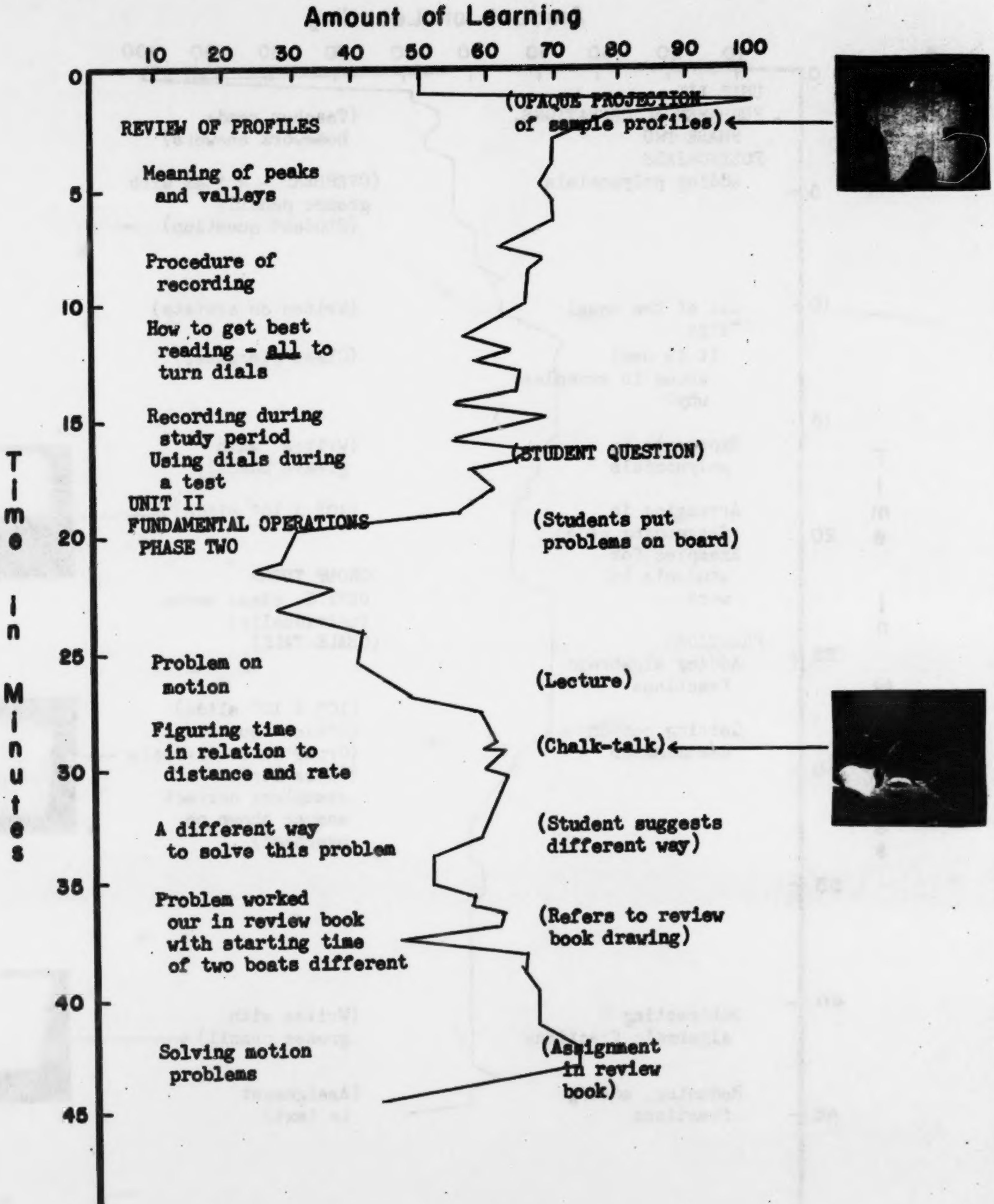

CONTROL GROUP

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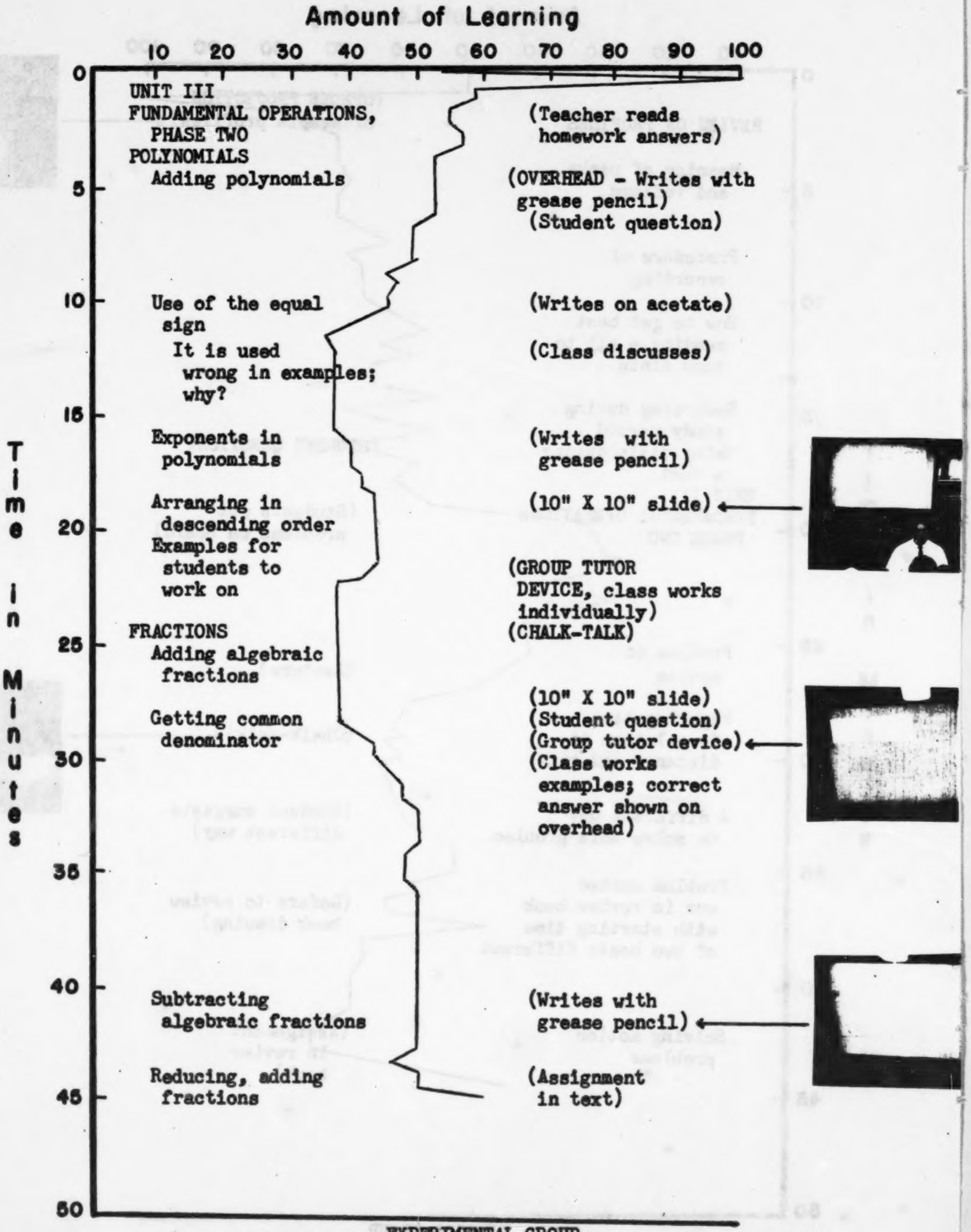

EXPERIMENTAL GROUP

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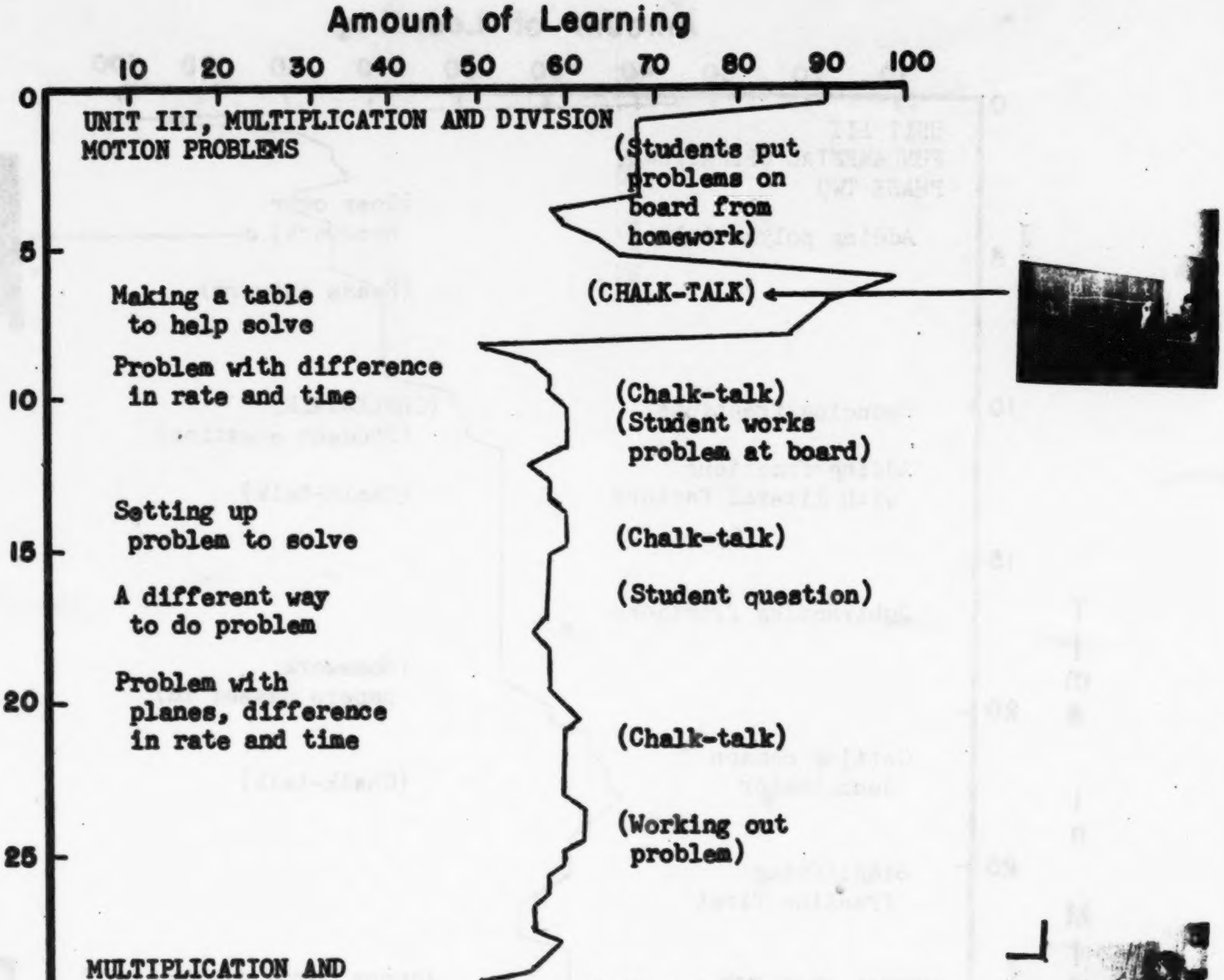
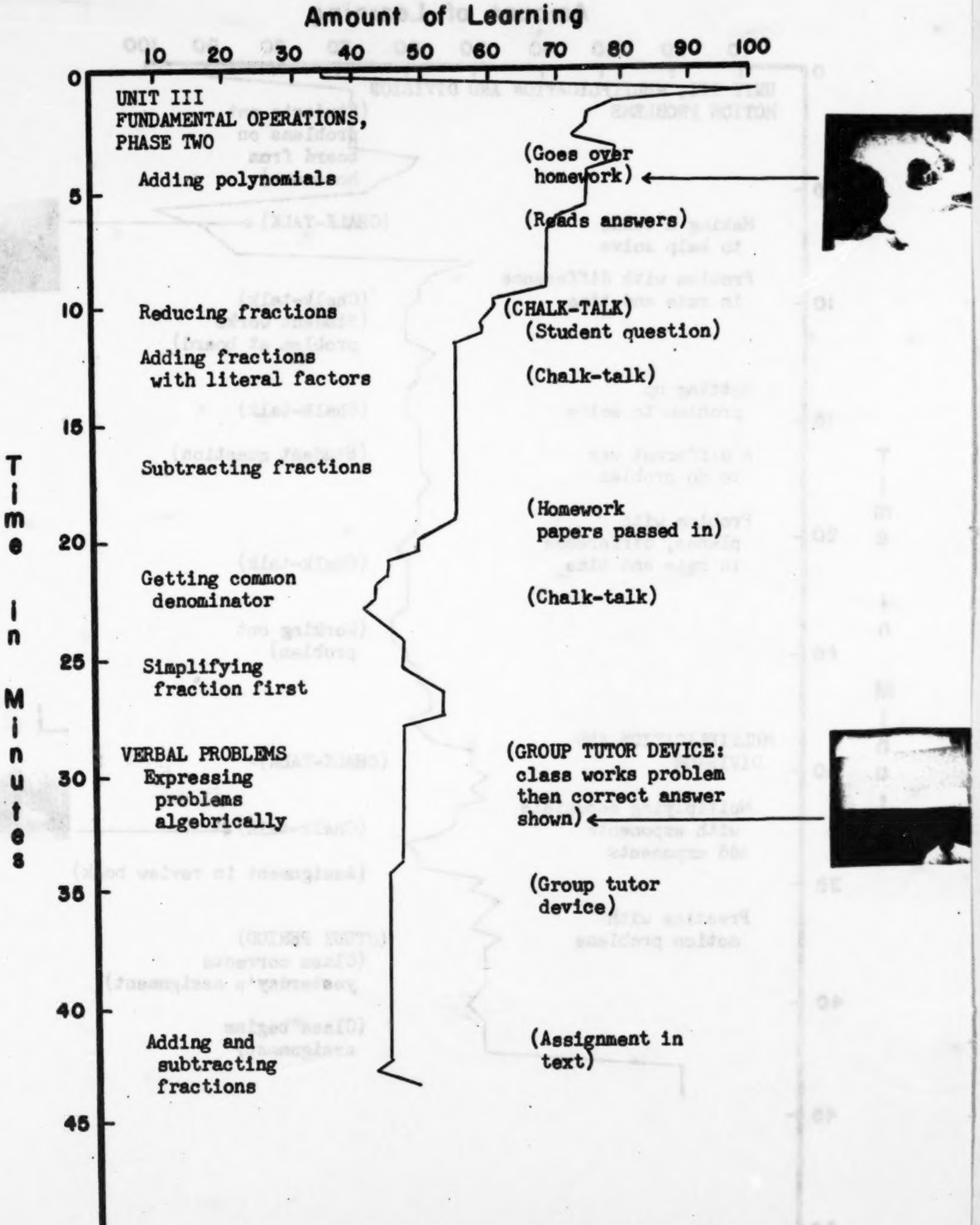


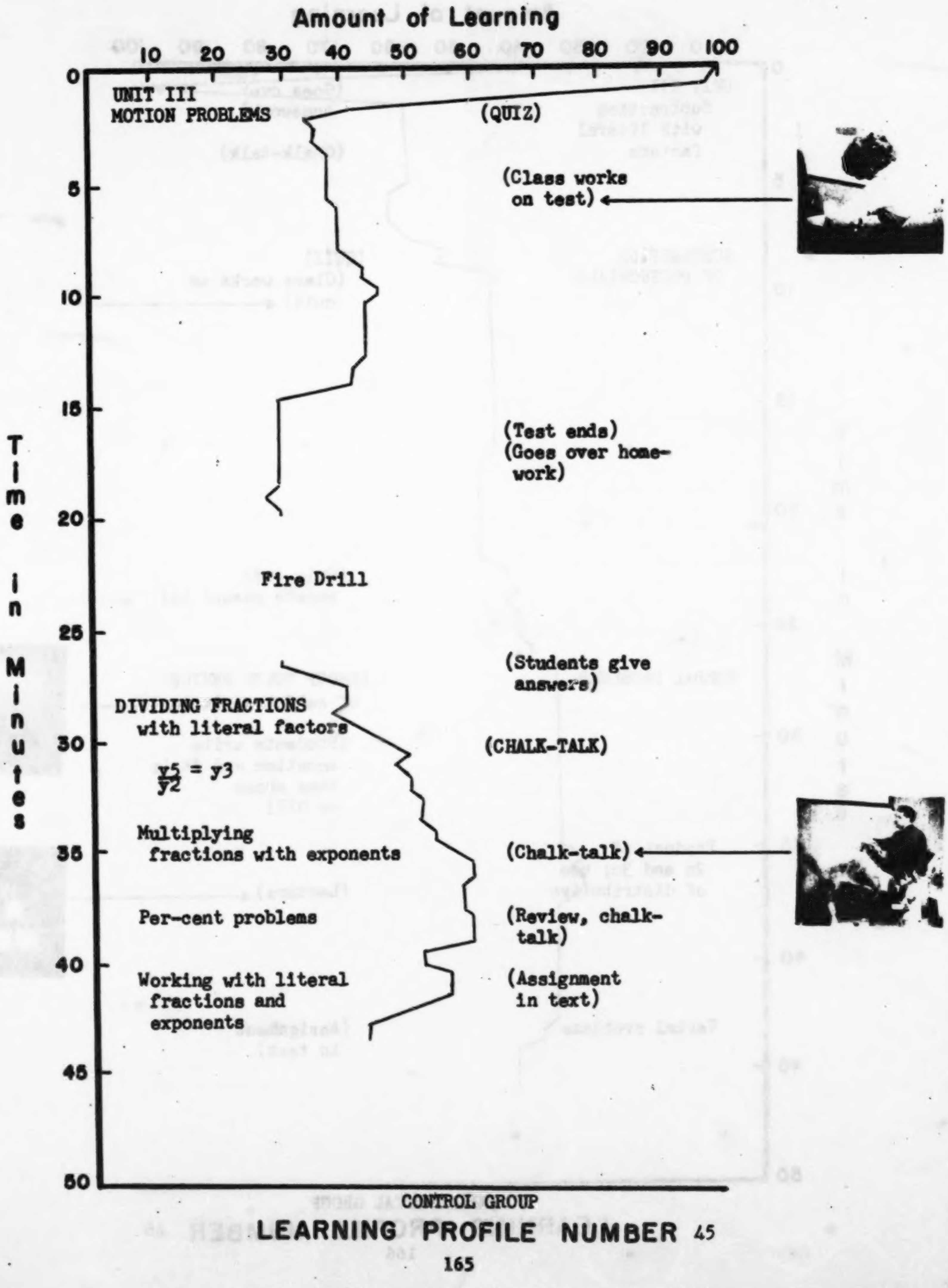
CONTROL GROUP

LEARNING PROFILE NUMBER 43



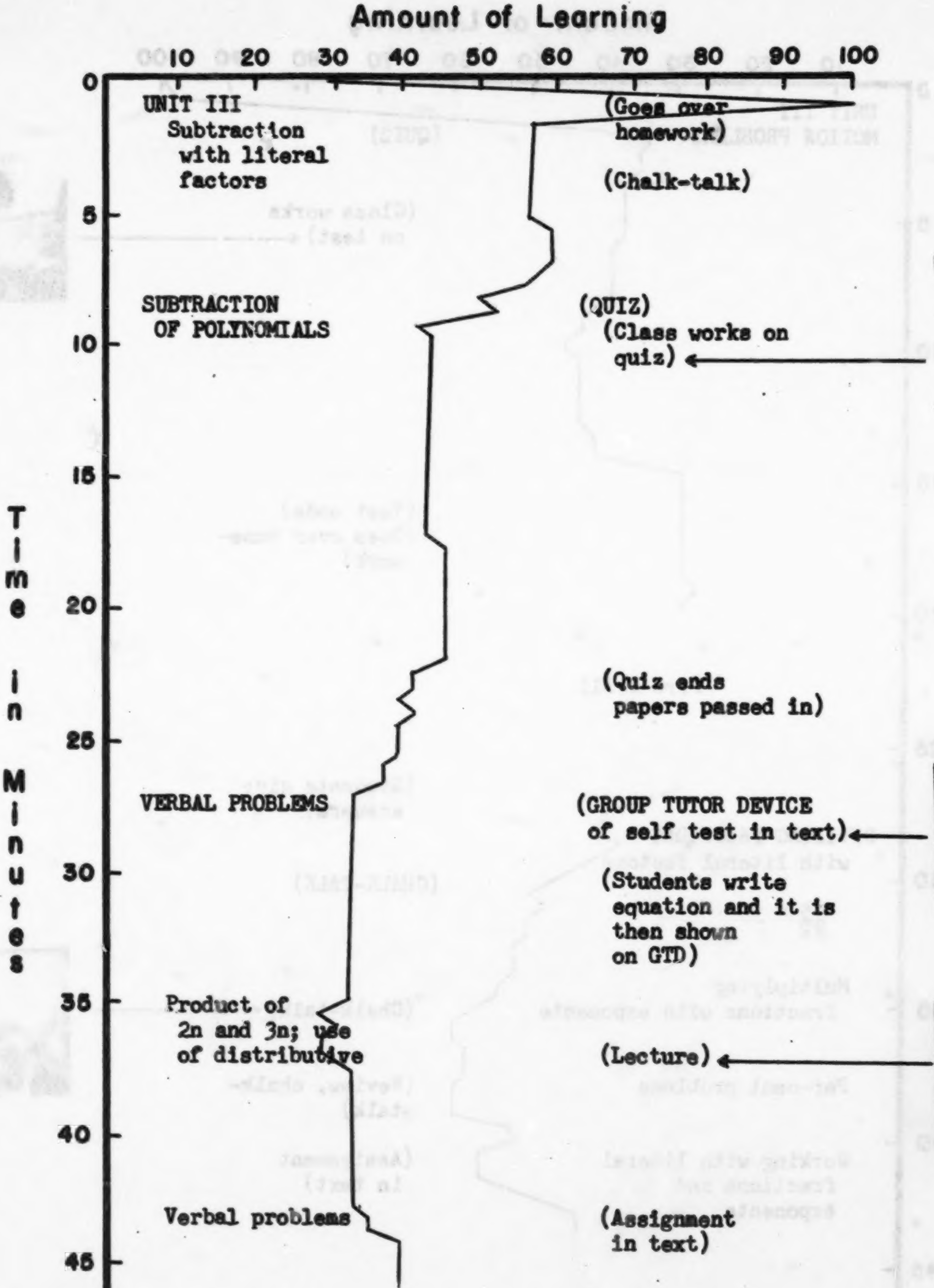
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 44



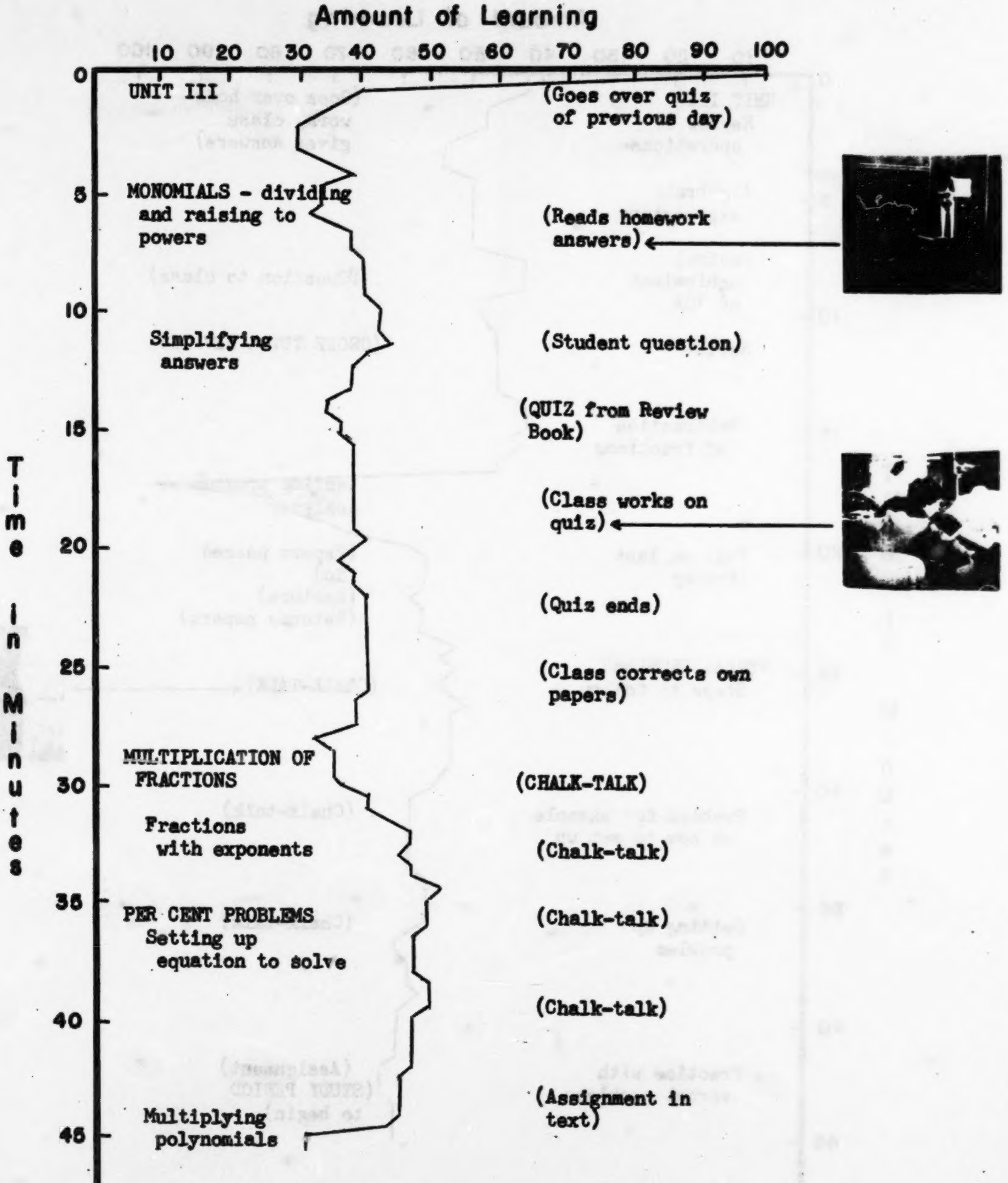
CONTROL GROUP

LEARNING PROFILE NUMBER 45



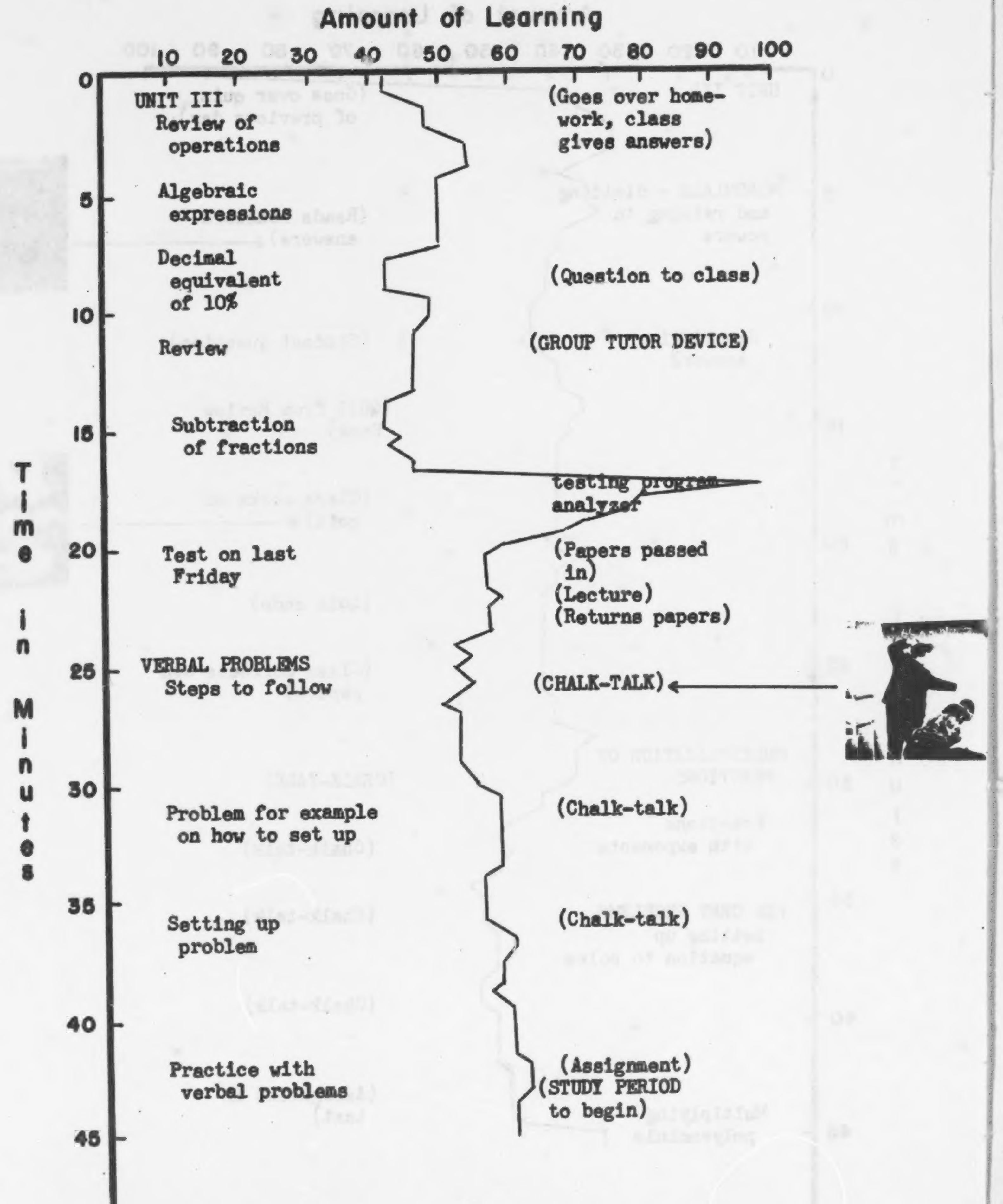
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 46



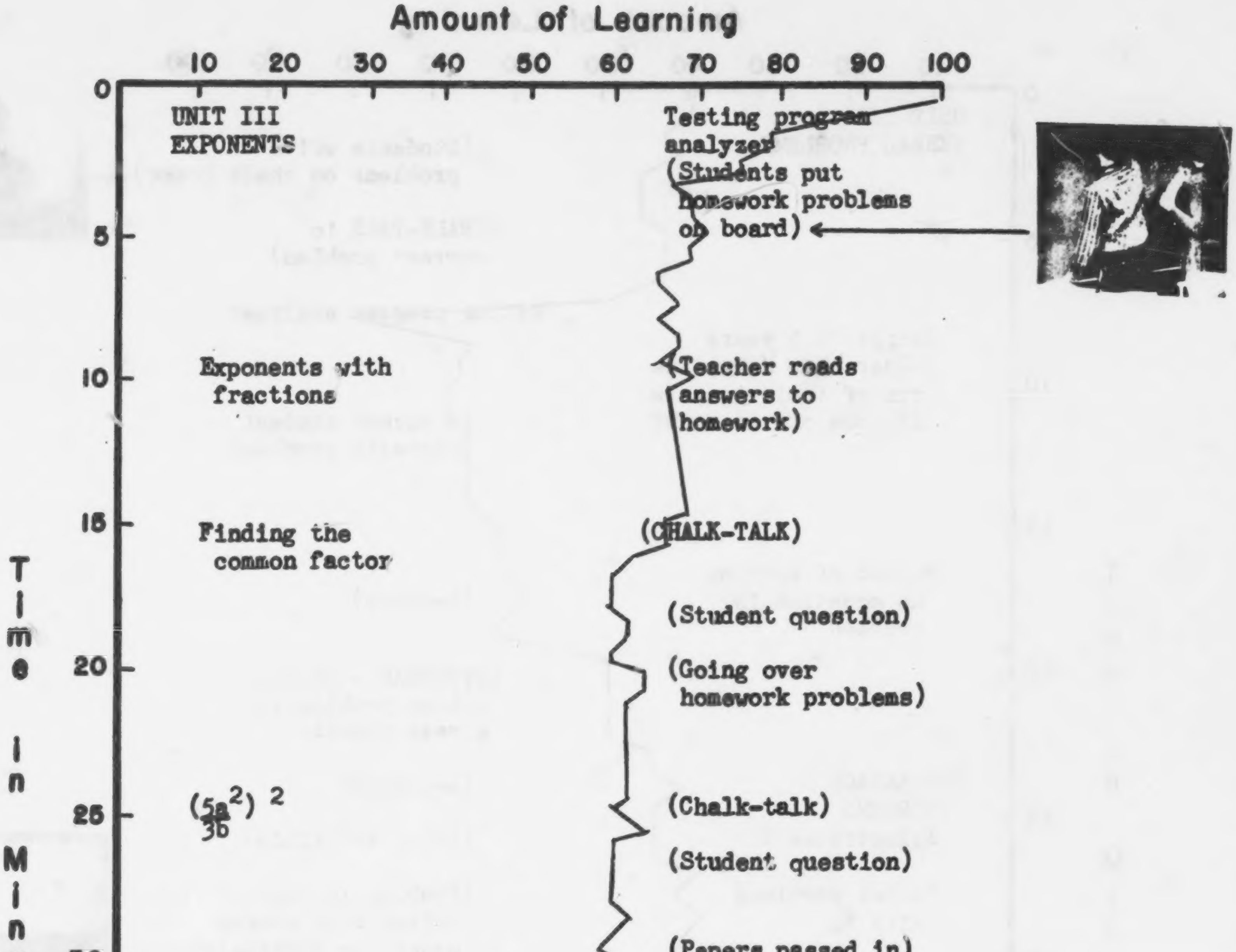
CONTROL GROUP

LEARNING PROFILE NUMBER 47



EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 48



CONTROL GROUP

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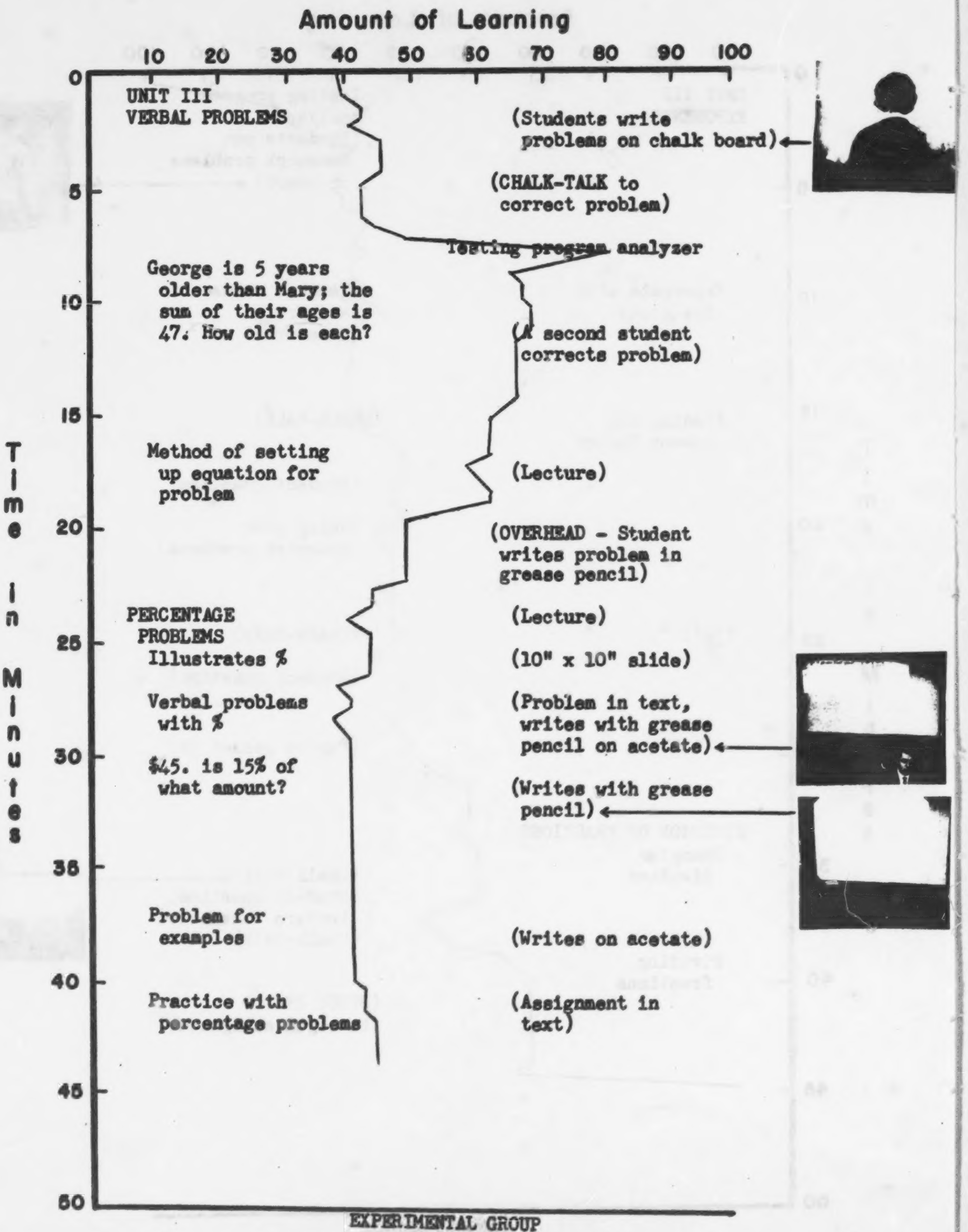
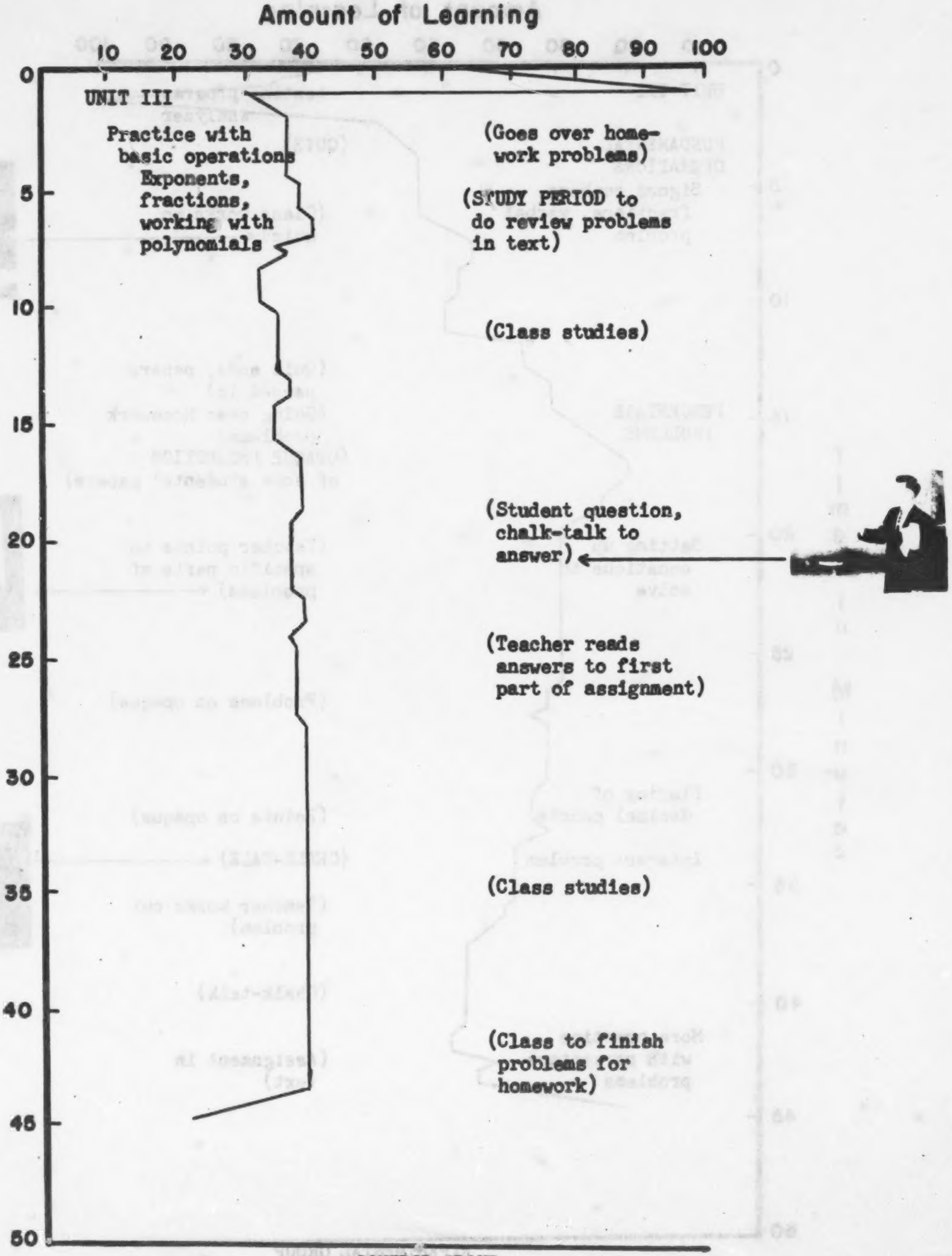


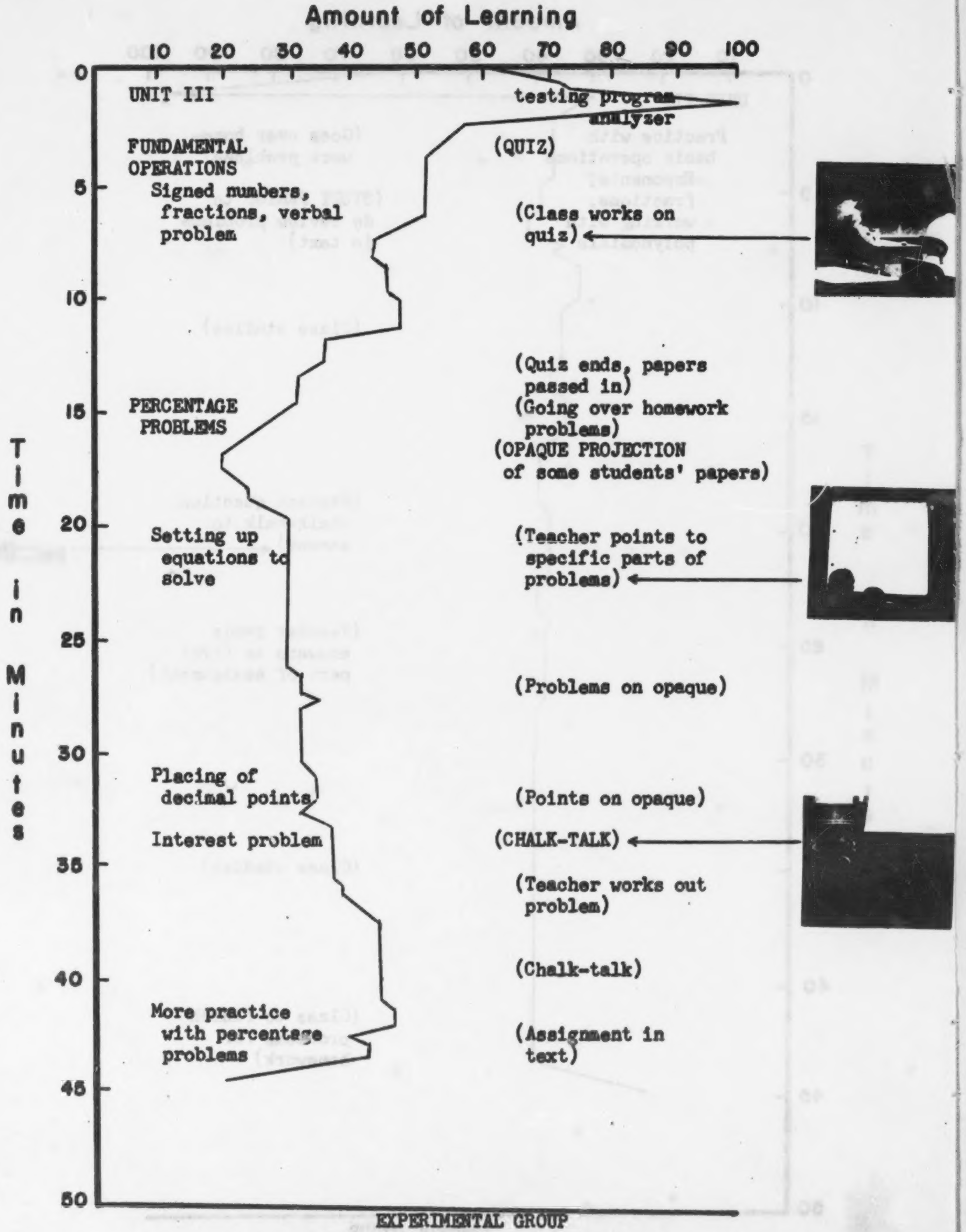
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 50



CONTROL GROUP

LEARNING PROFILE NUMBER 51



EXPERIMENTAL GROUP

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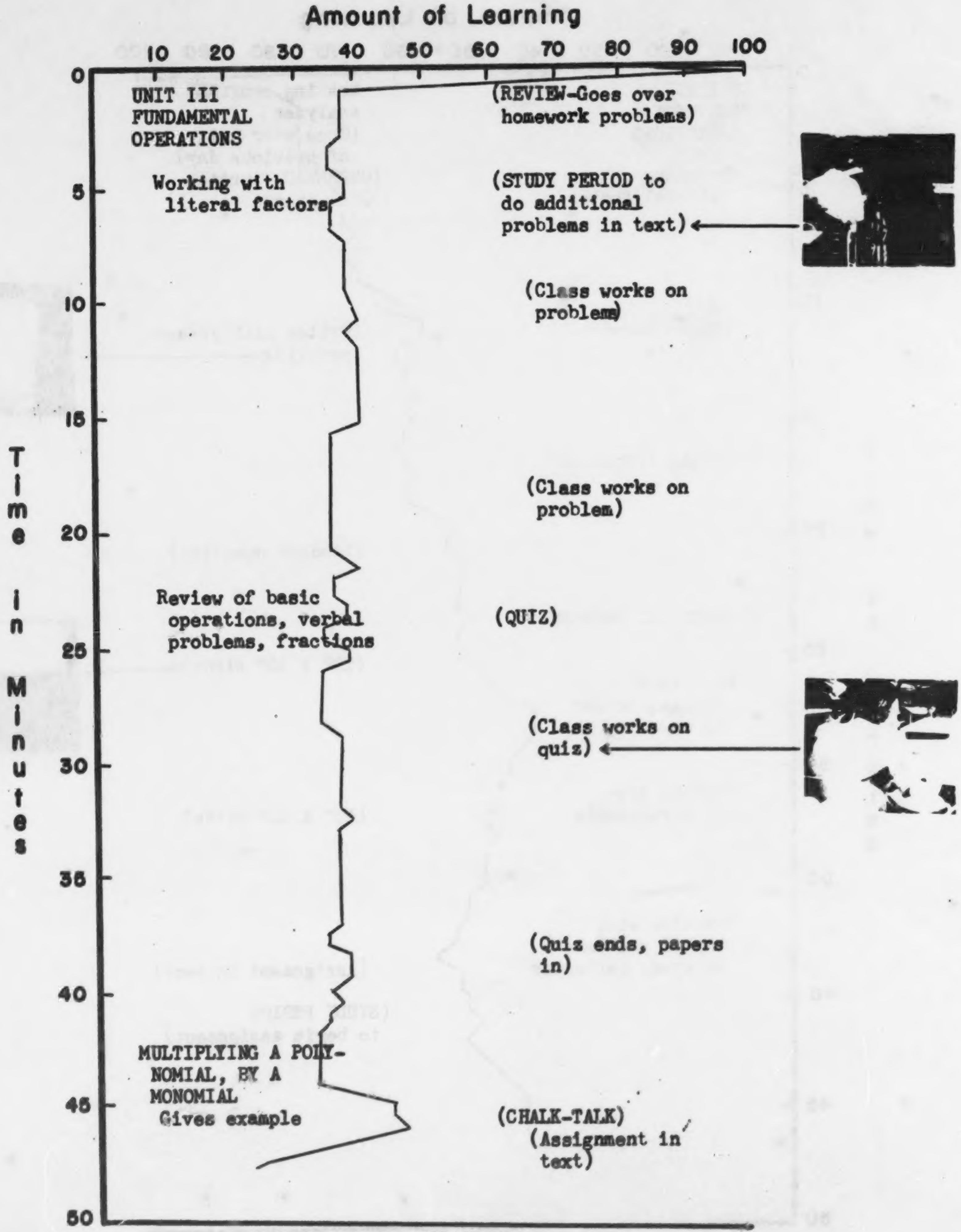
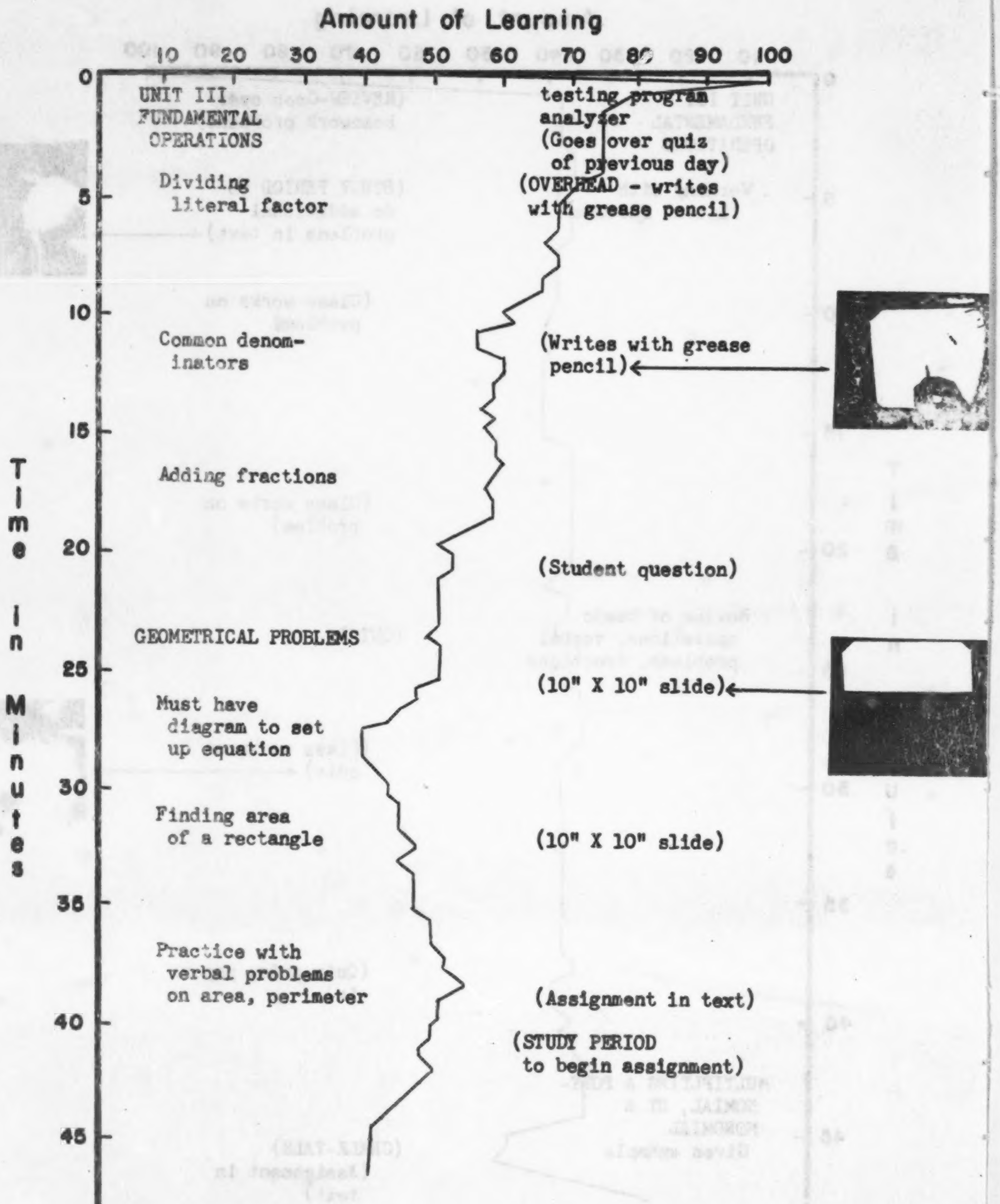


CONTROL GROUP

LEARNING PROFILE NUMBER 53



EXPERIMENTAL GROUP

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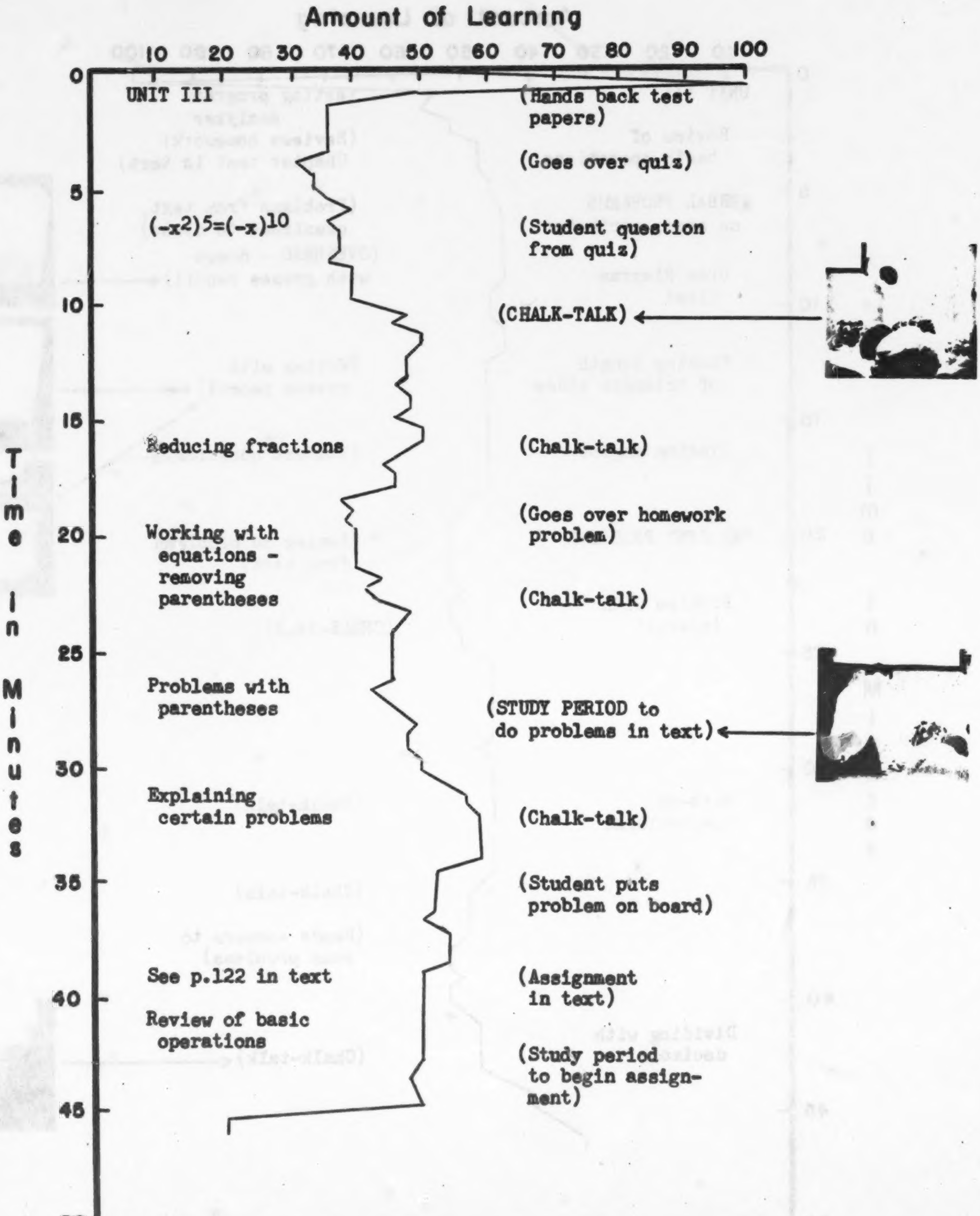
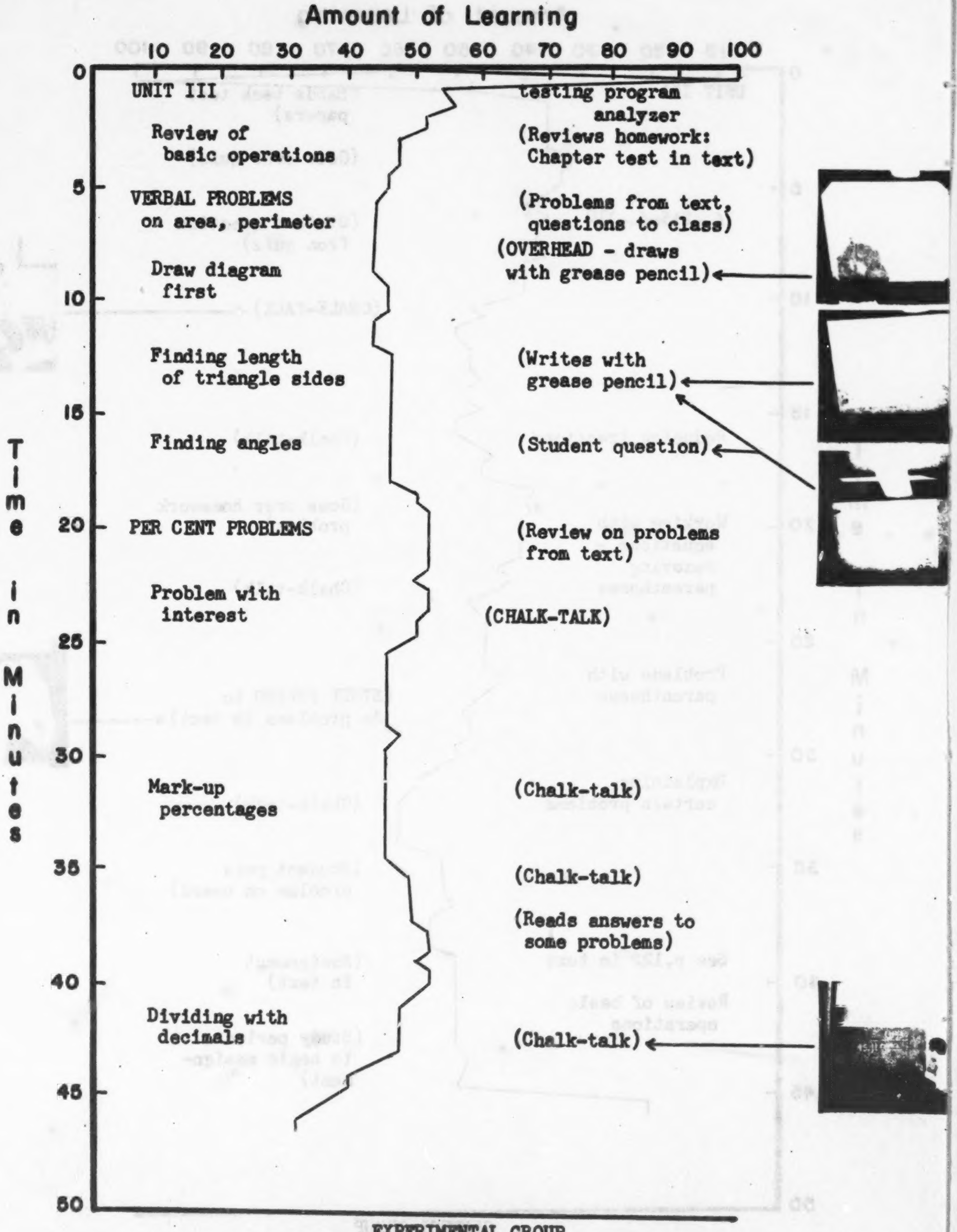


CONTROL GROUP

LEARNING PROFILE NUMBER 55



EXPERIMENTAL GROUP

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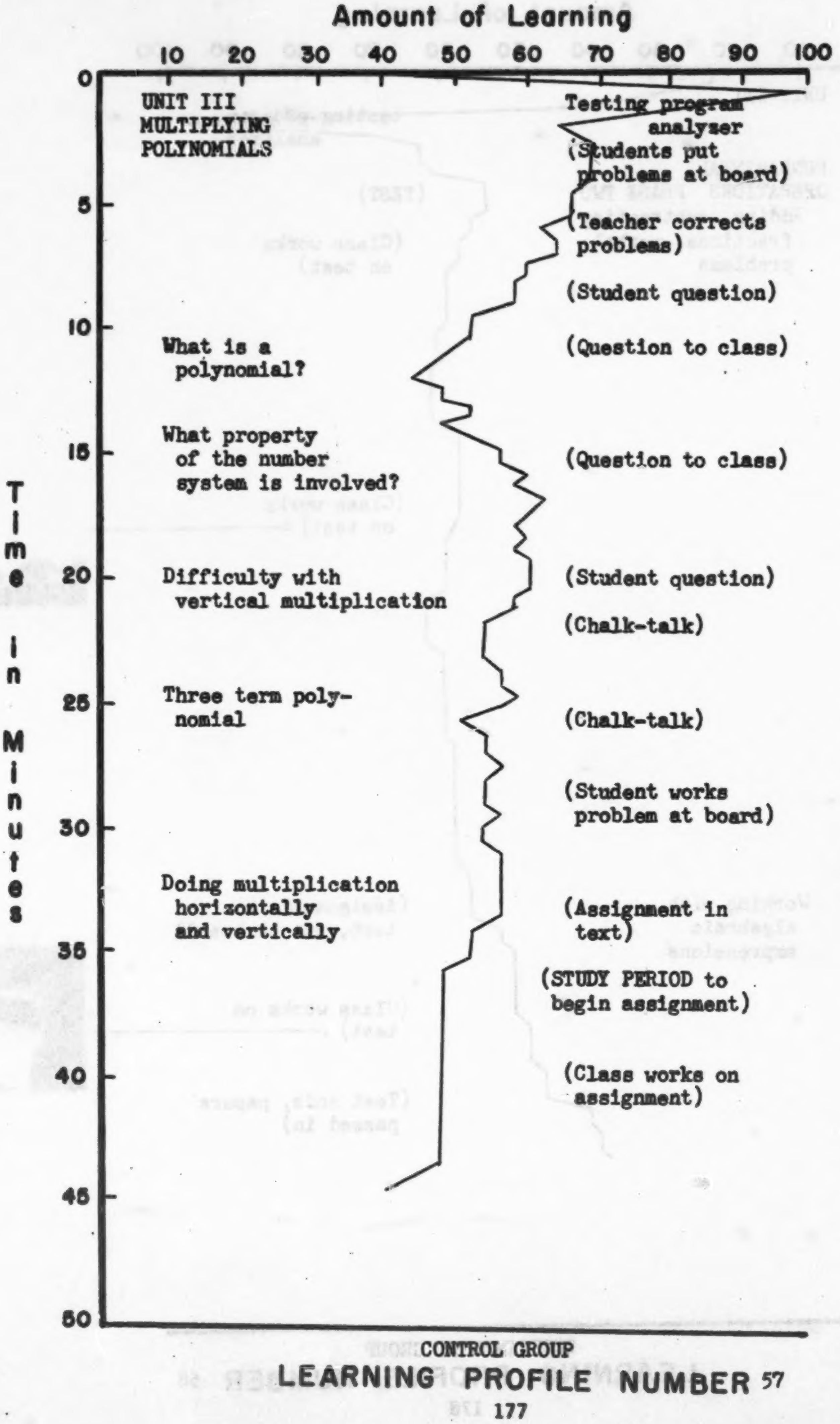
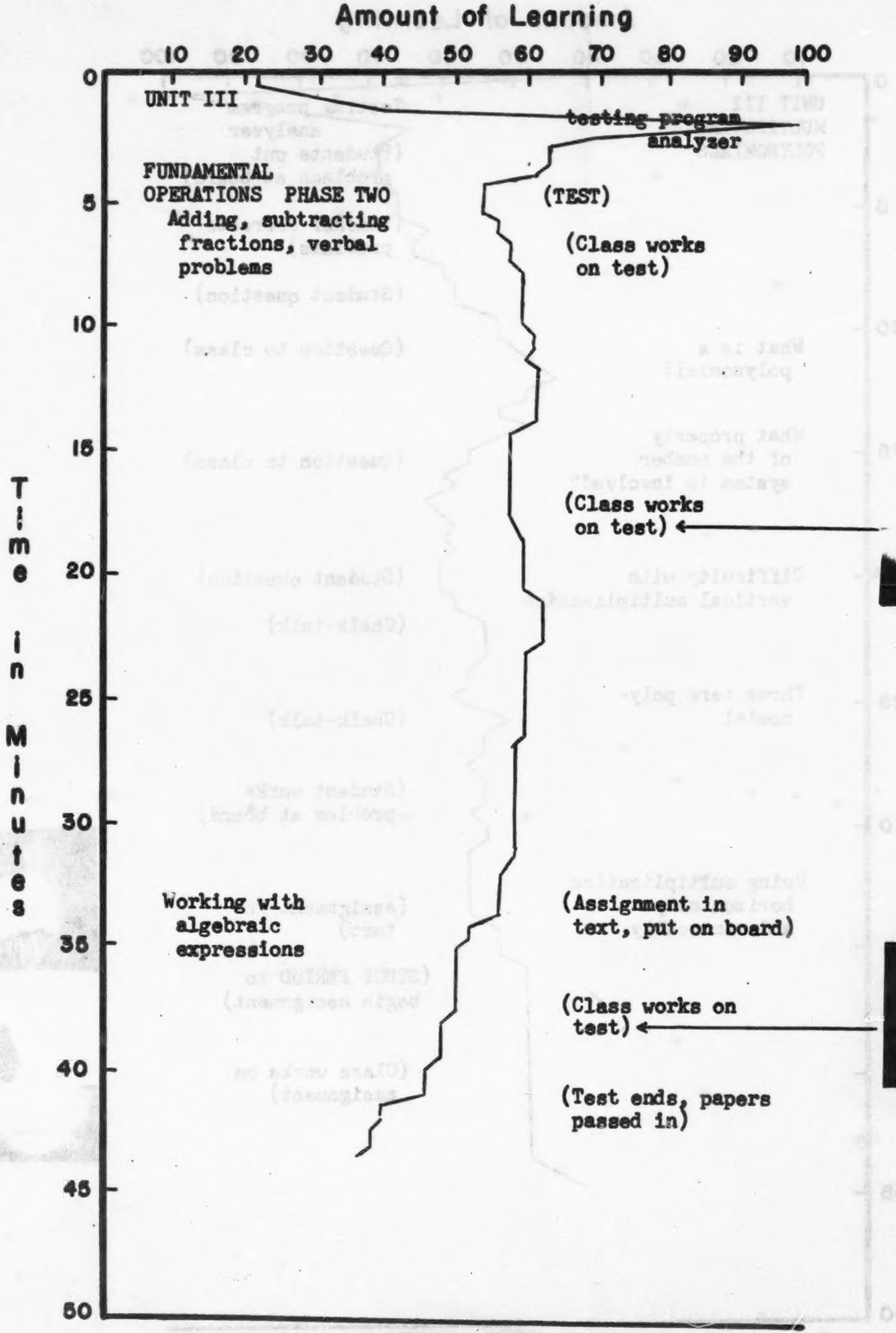


CONTROL GROUP

LEARNING PROFILE NUMBER 57



EXPERIMENTAL GROUP

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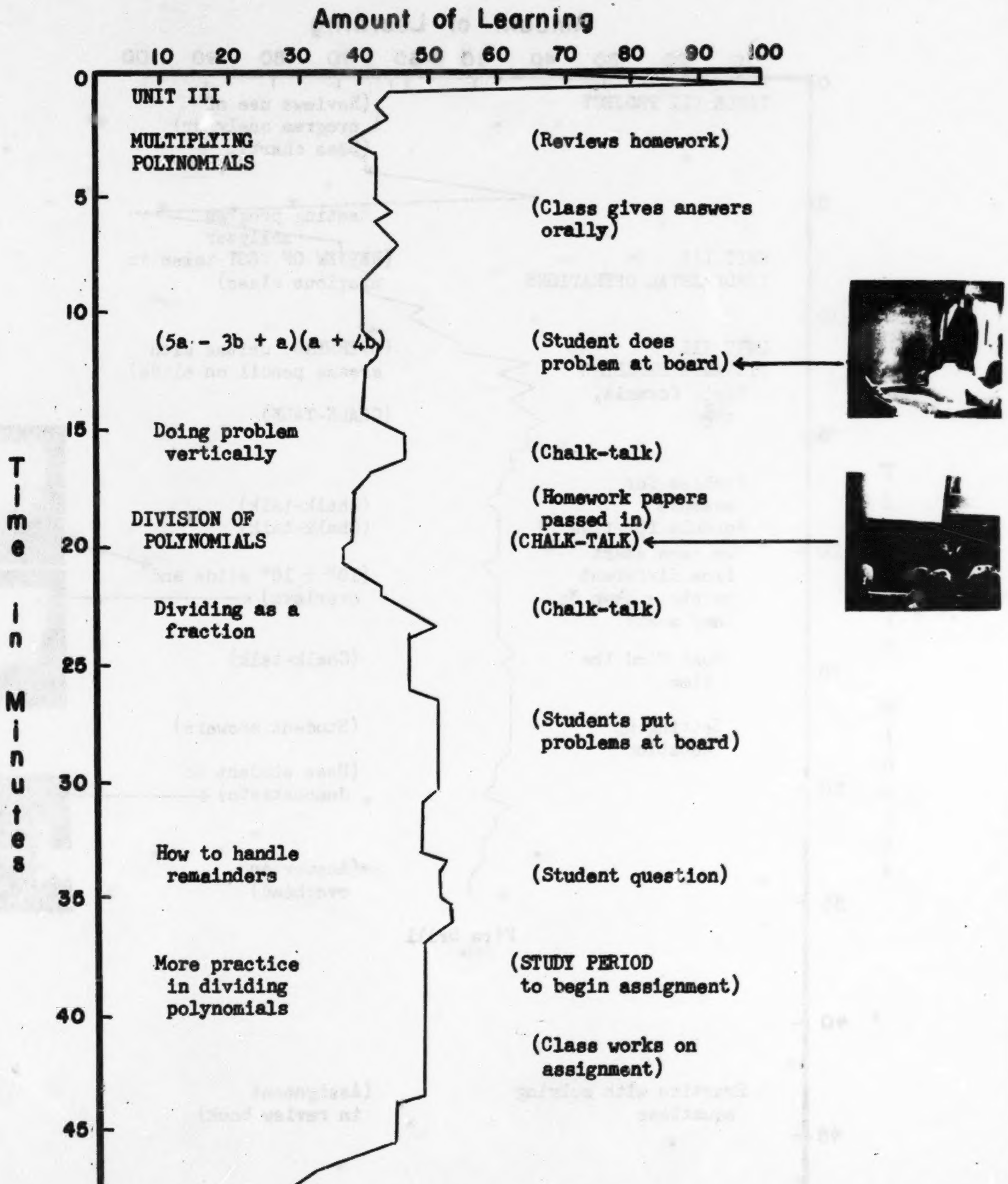
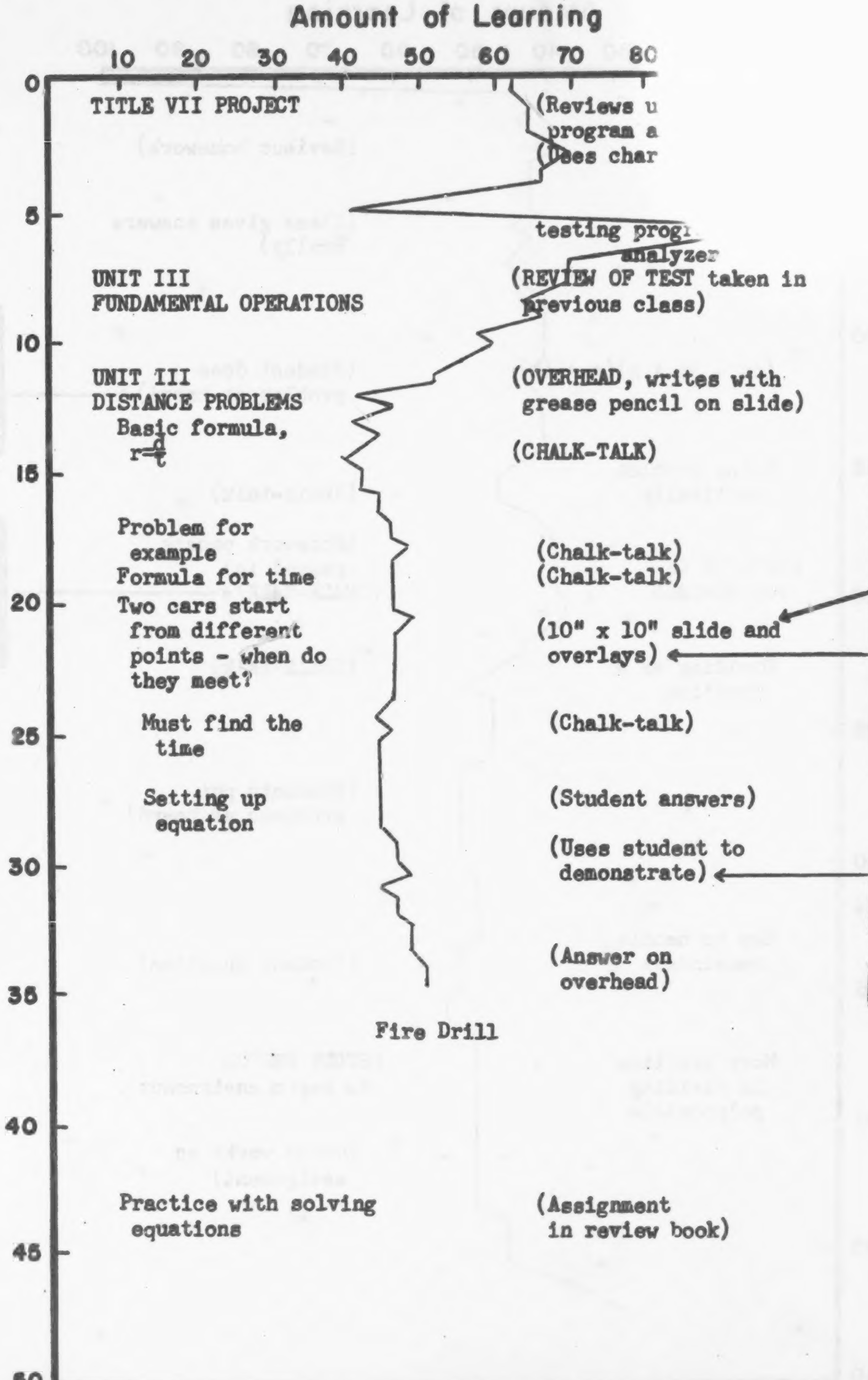


CONTROL GROUP

LEARNING PROFILE NUMBER 59



EXPERIMENTAL GROUP

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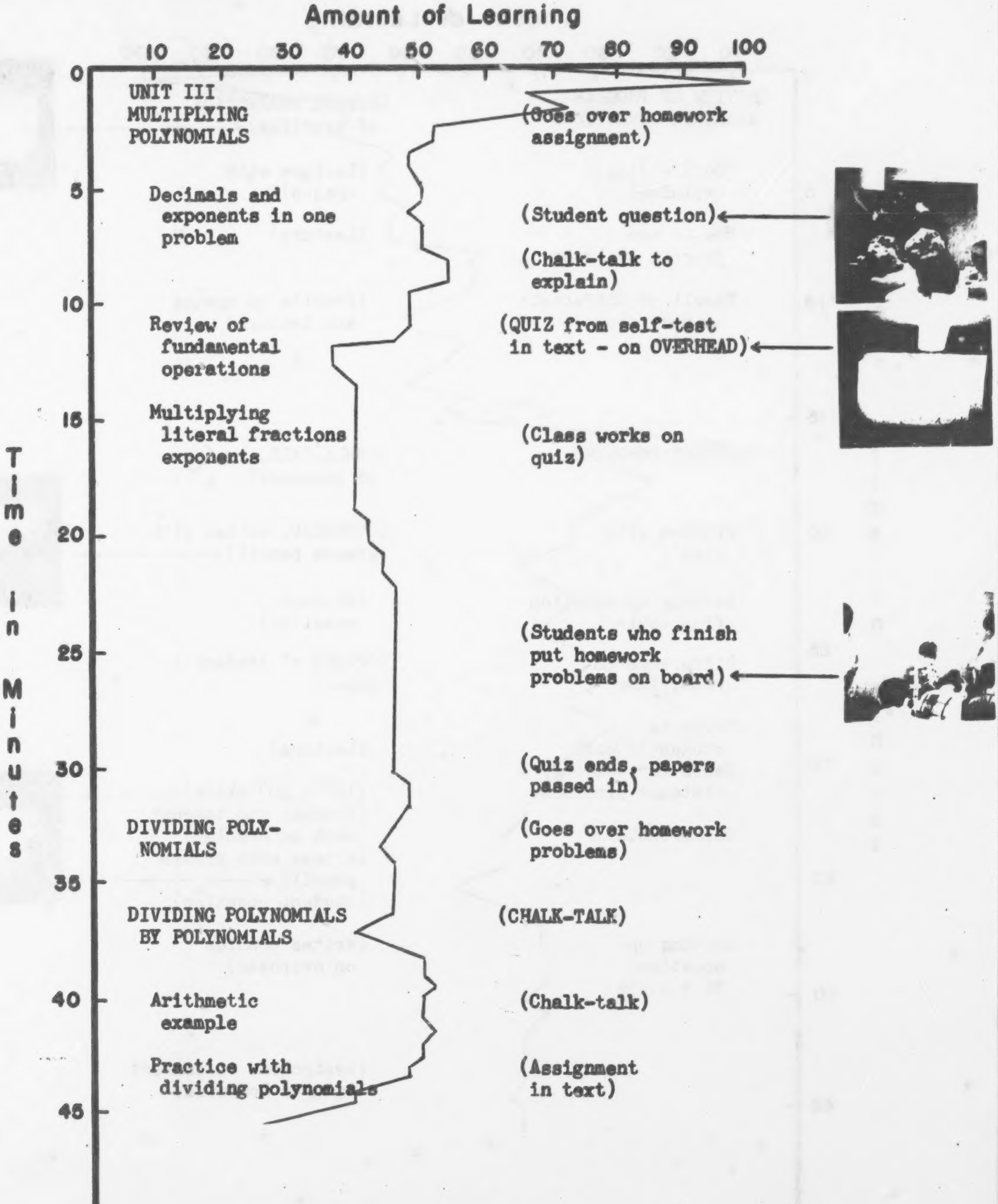
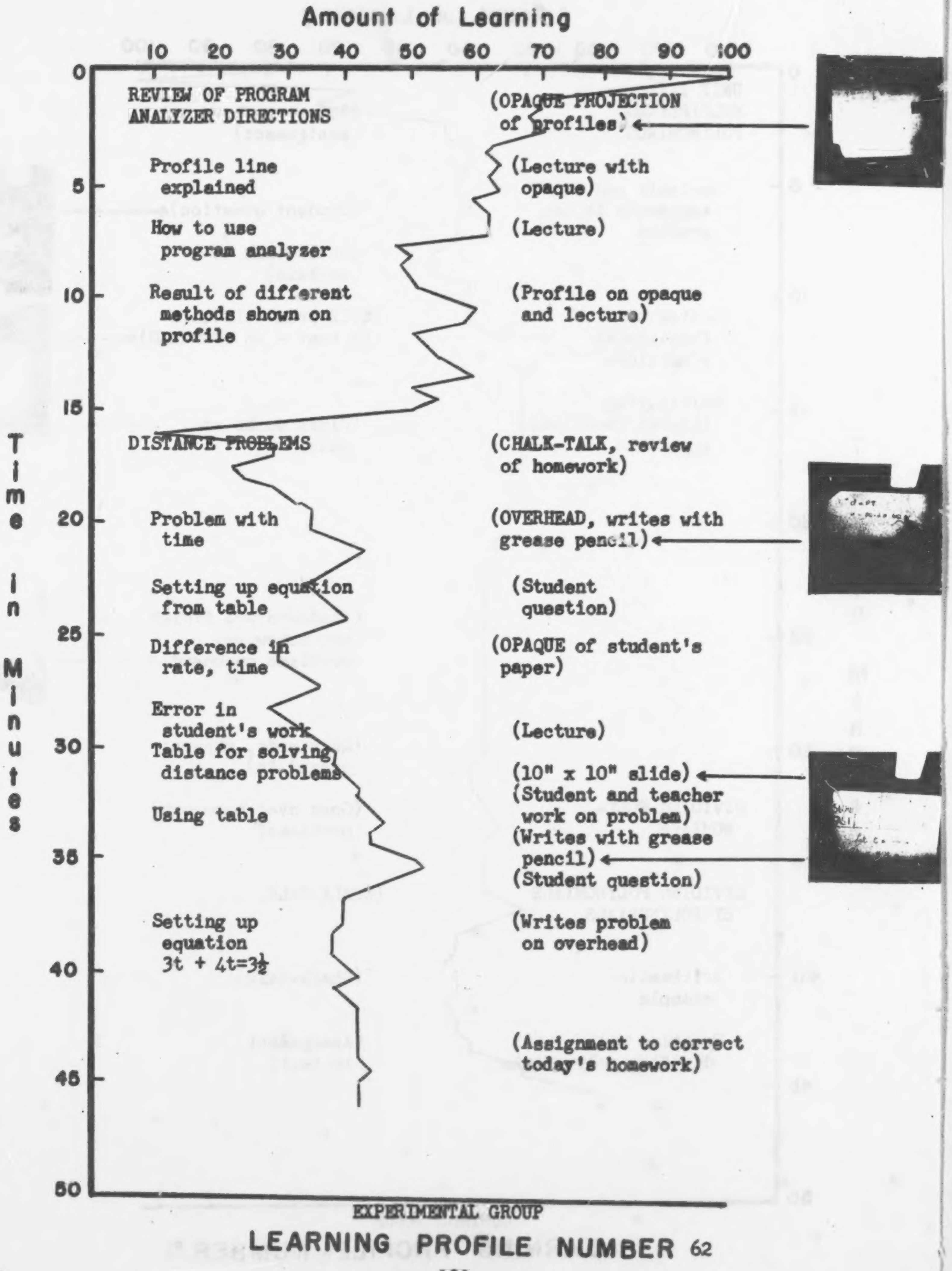


CONTROL GROUP

LEARNING PROFILE NUMBER 61



EXPERIMENTAL GROUP

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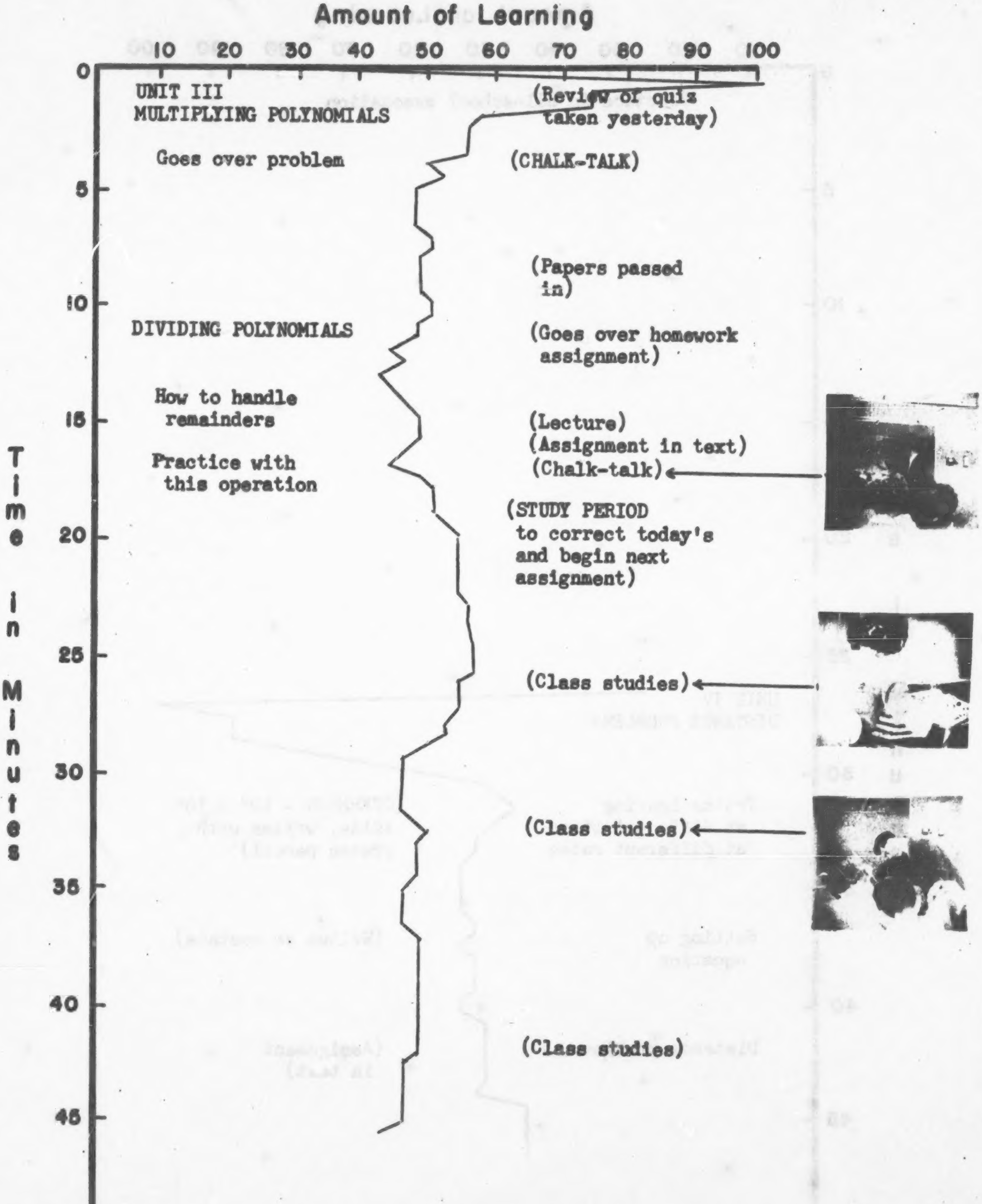

CONTROL GROUP

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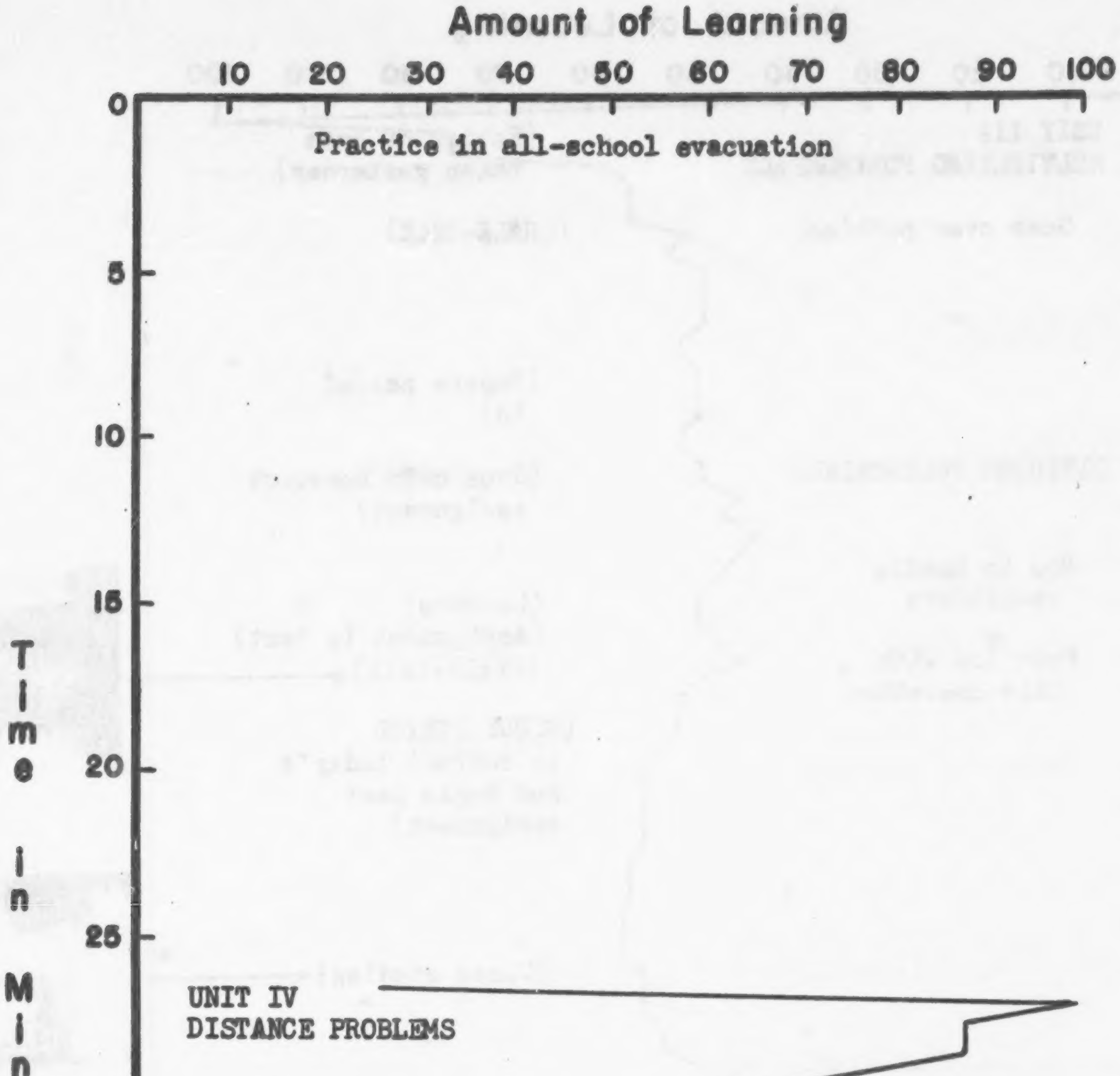
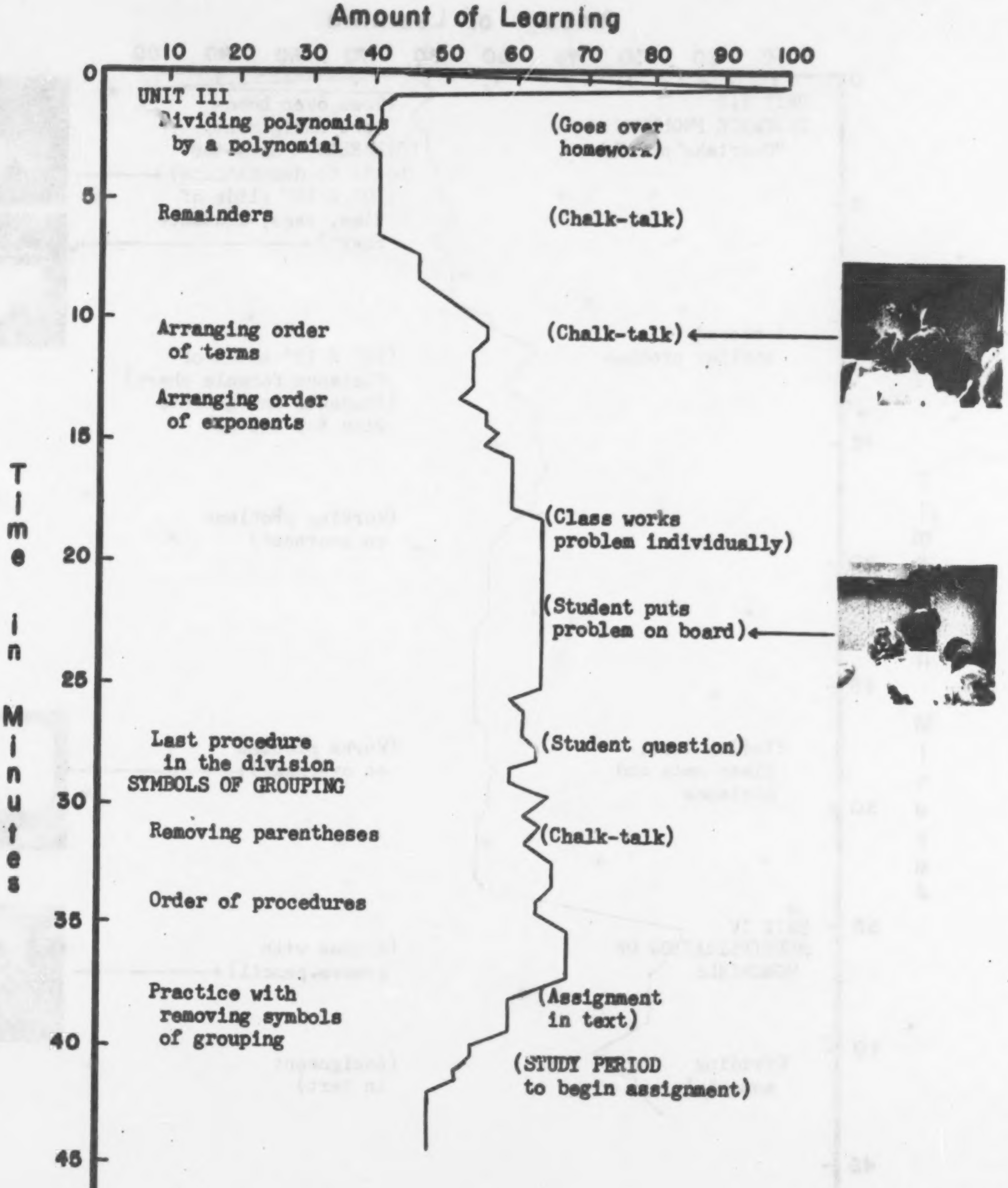


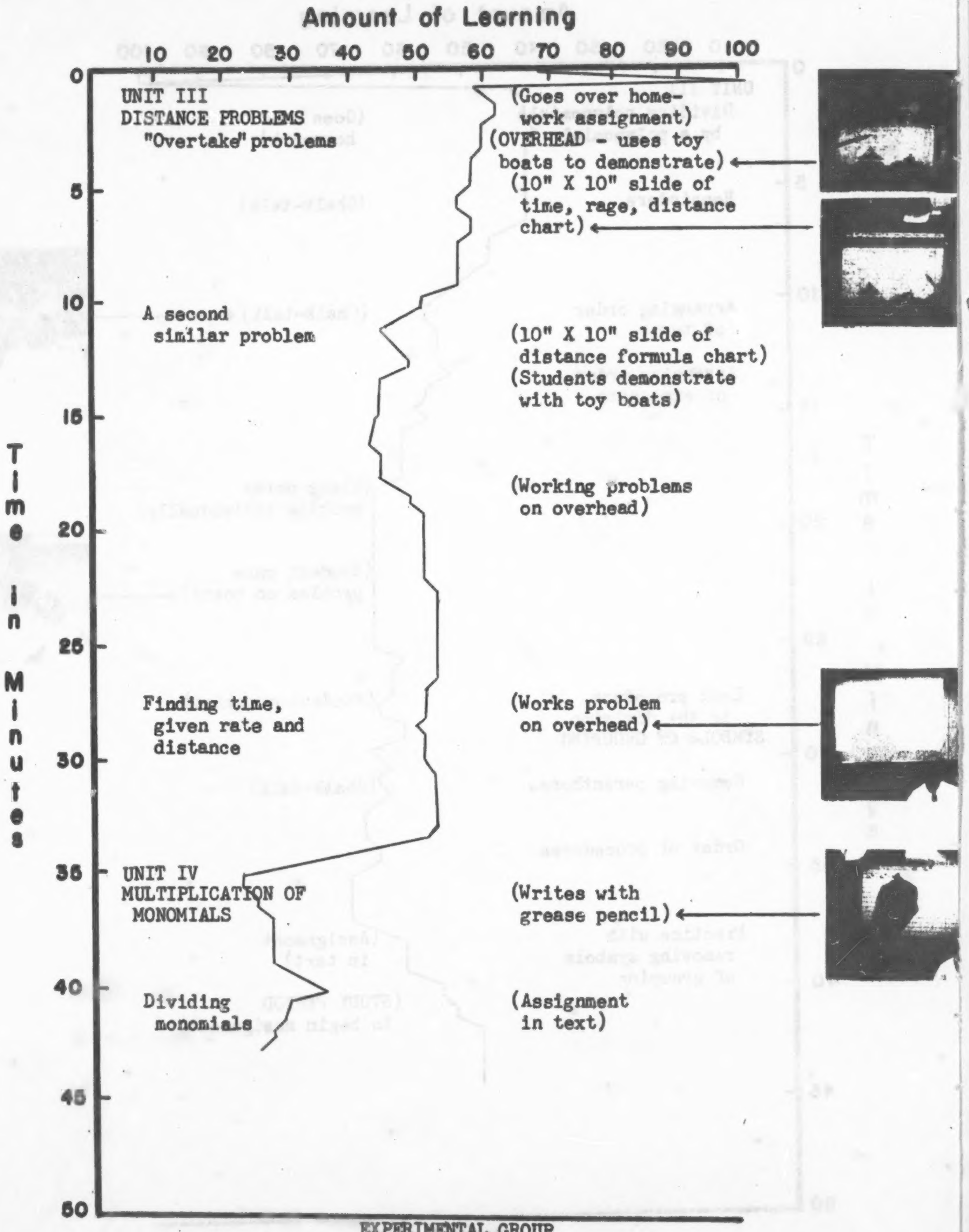
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 64



CONTROL GROUP

LEARNING PROFILE NUMBER 65



EXPERIMENTAL GROUP

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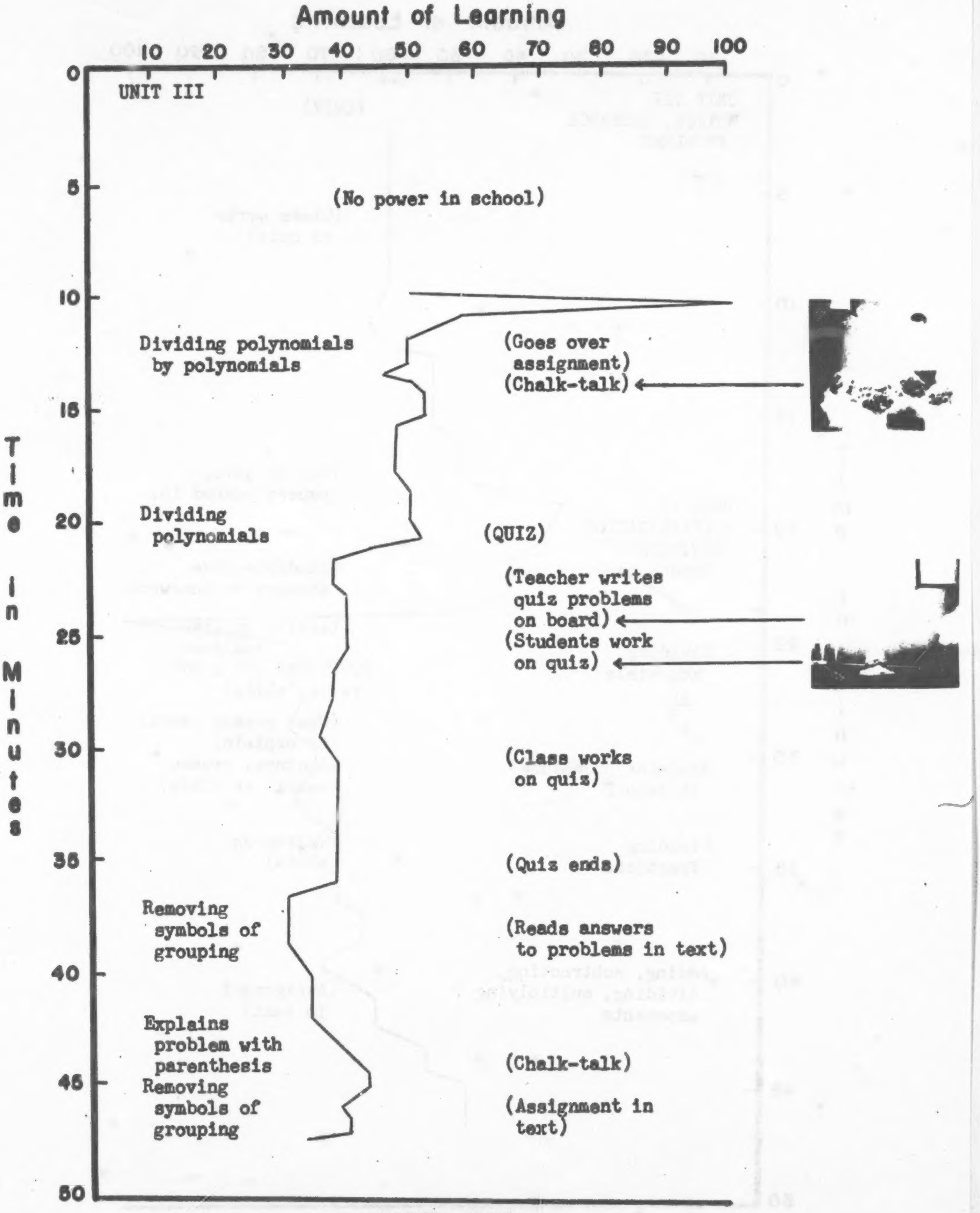
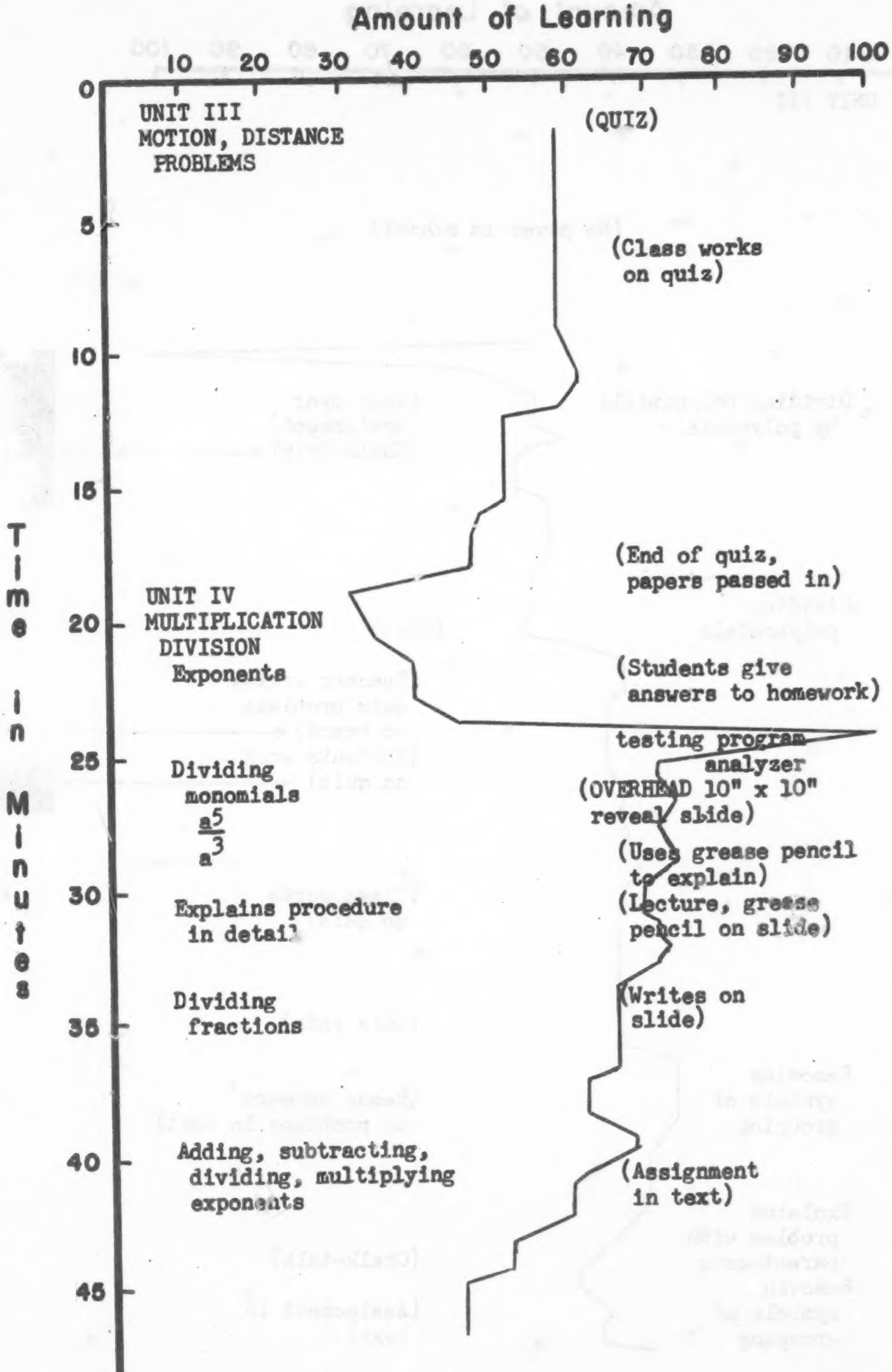


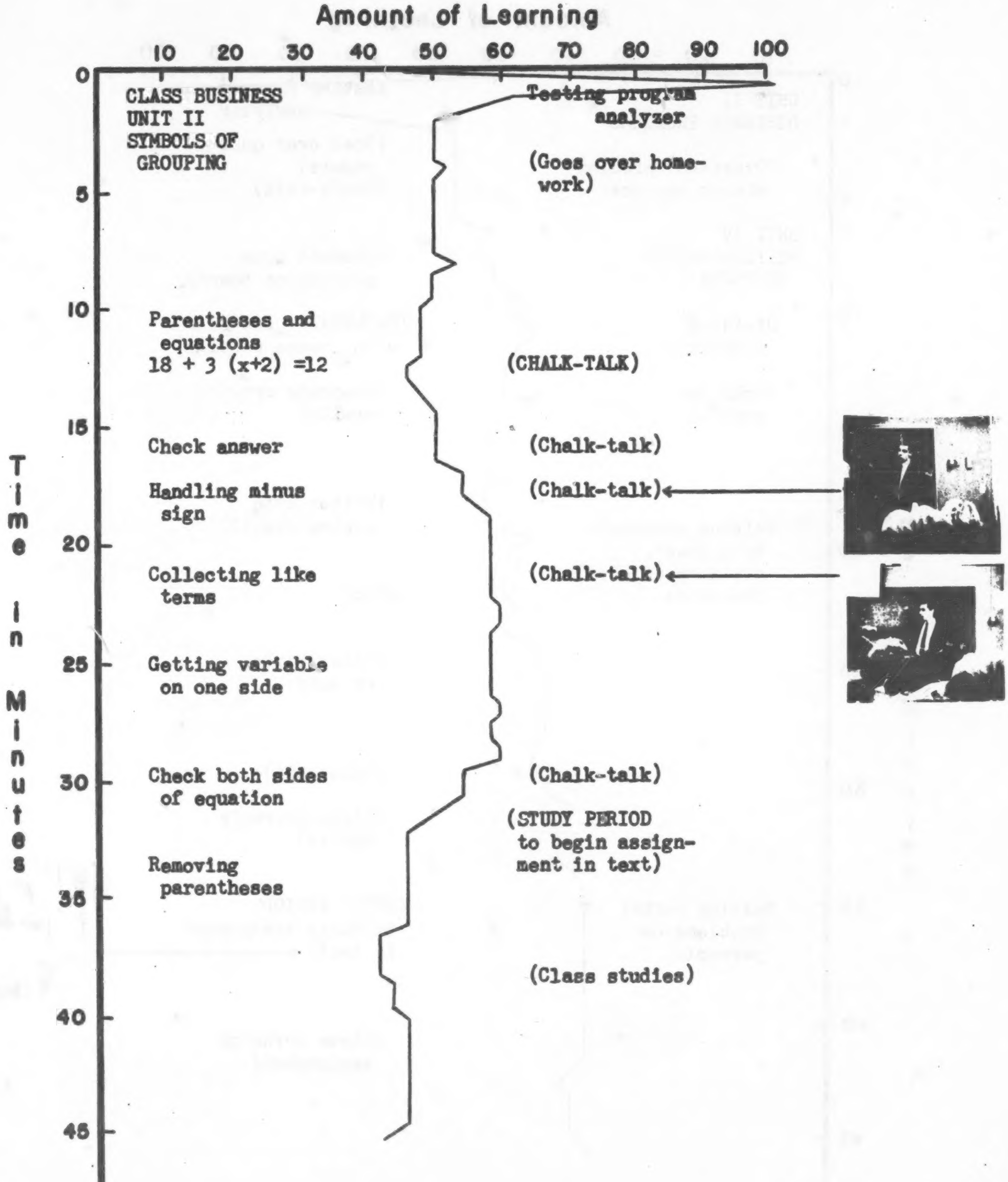
CONTROL GROUP

LEARNING PROFILE NUMBER 67



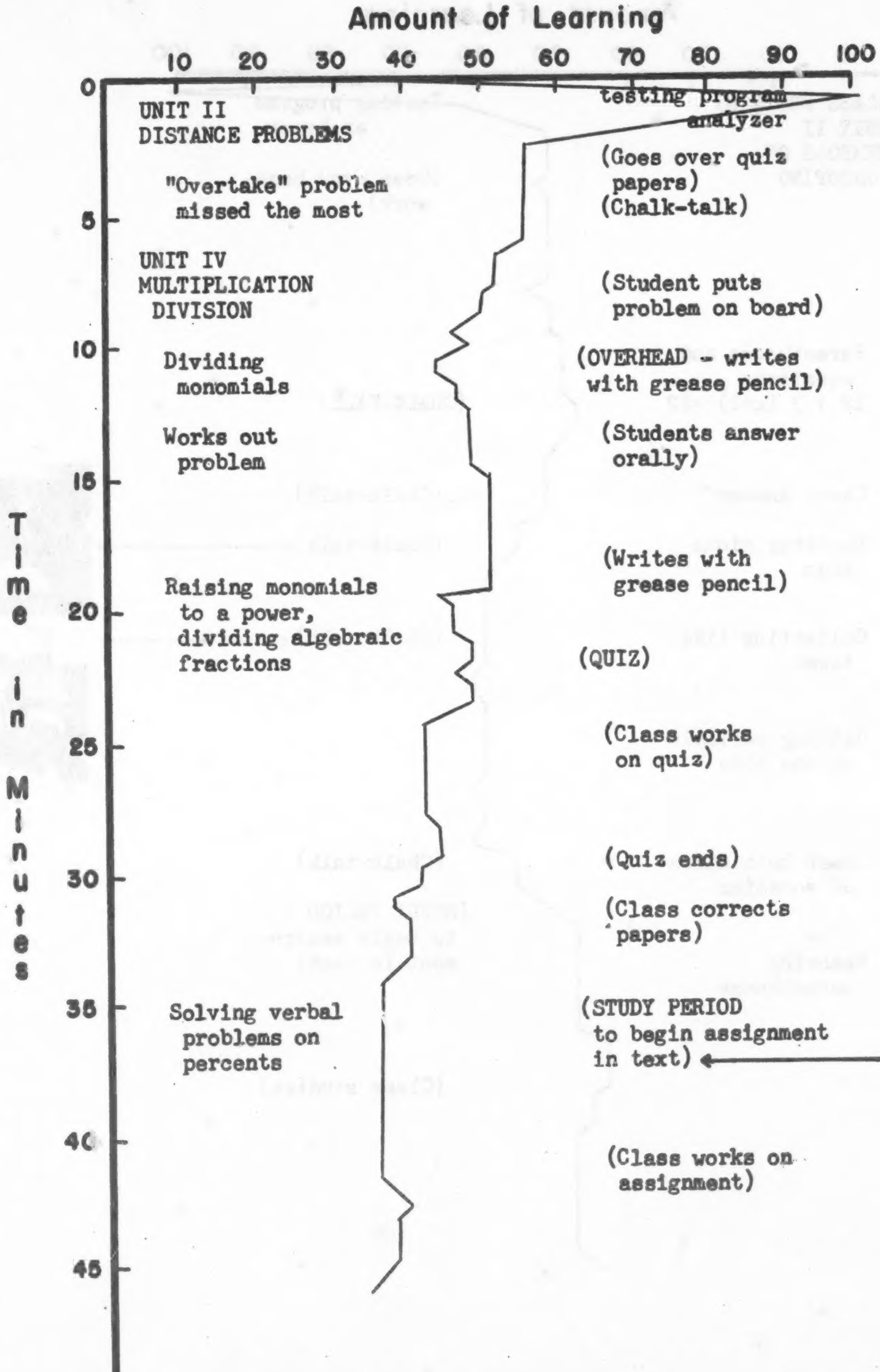
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 68



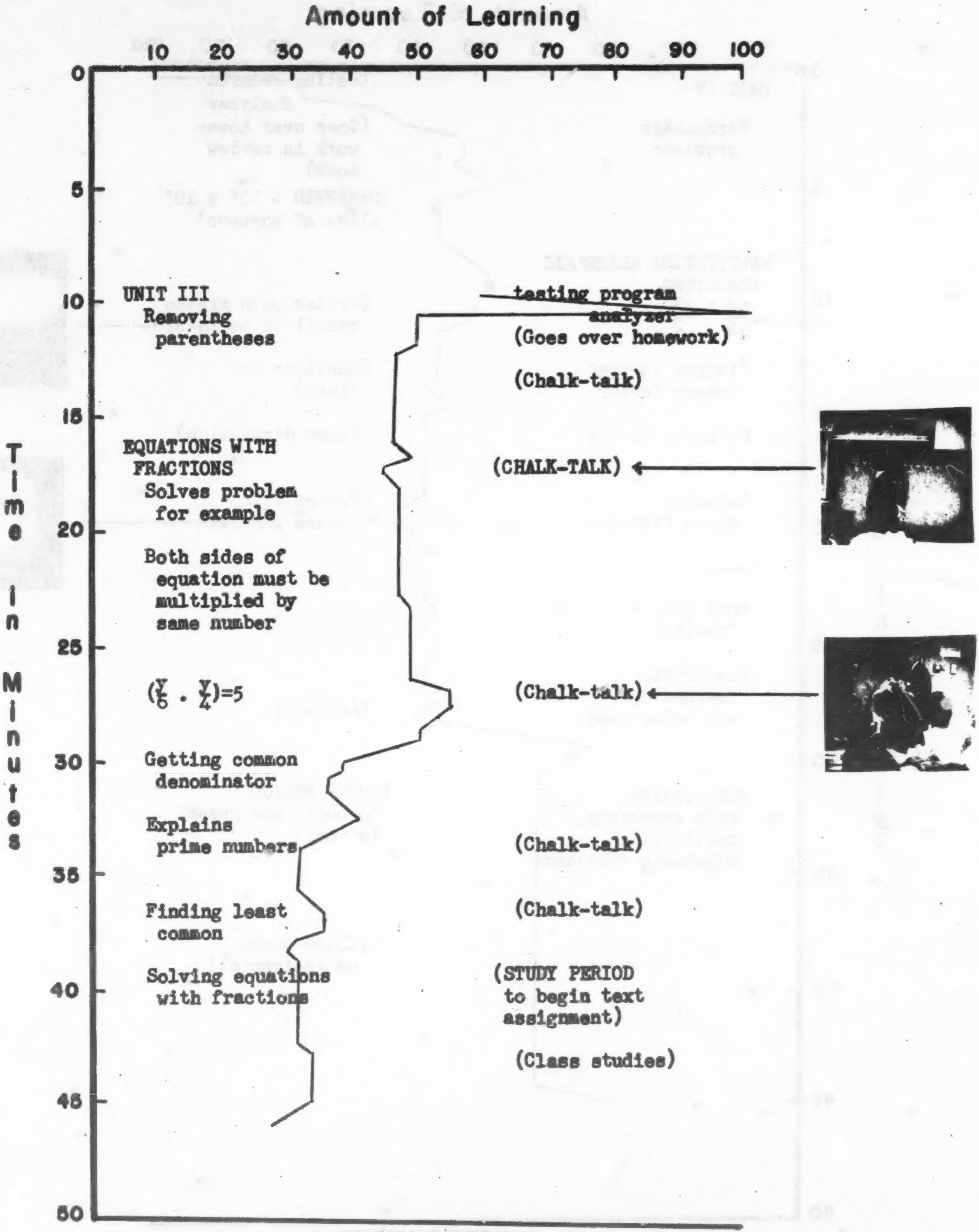
CONTROL GROUP

LEARNING PROFILE NUMBER 69



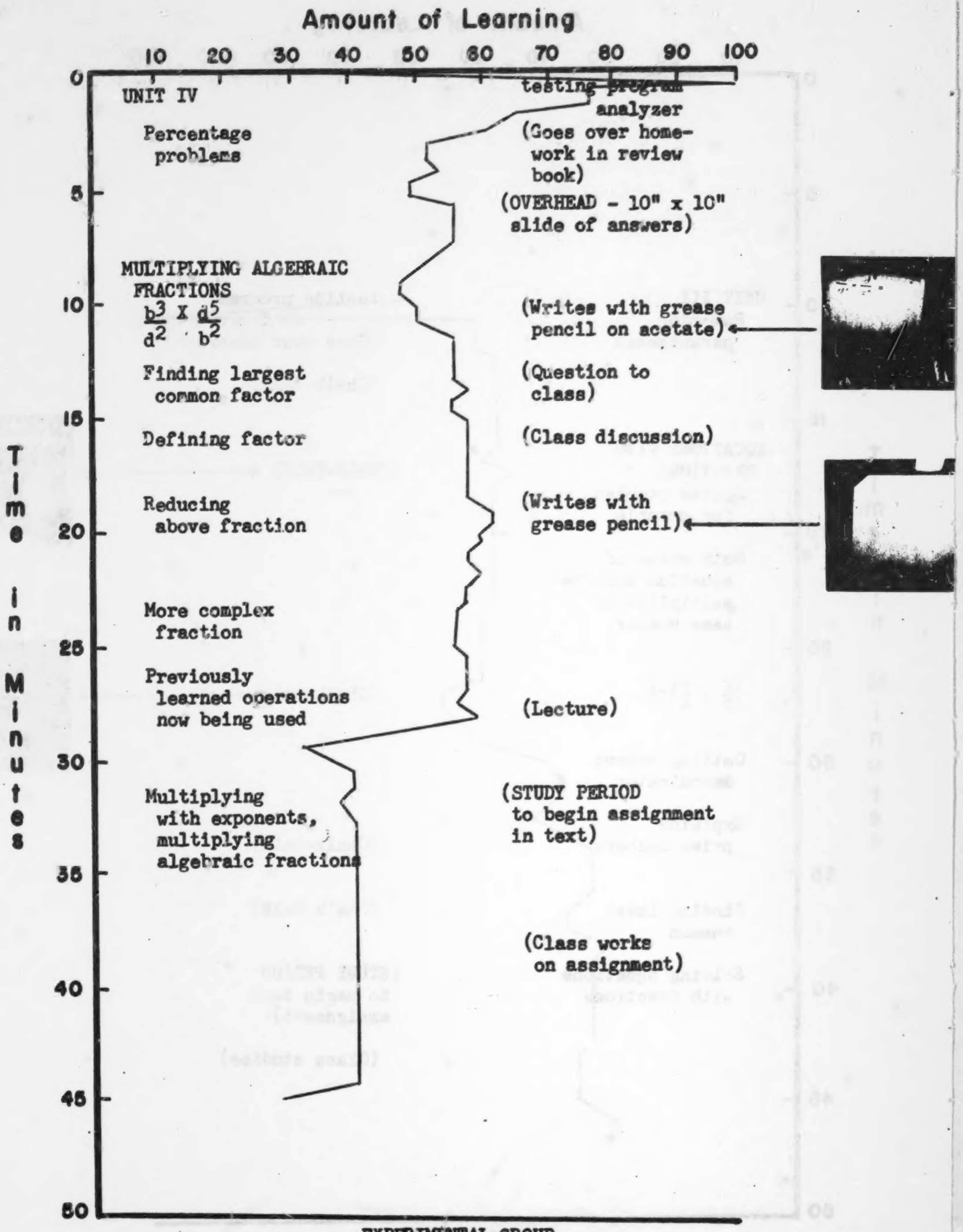
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 70



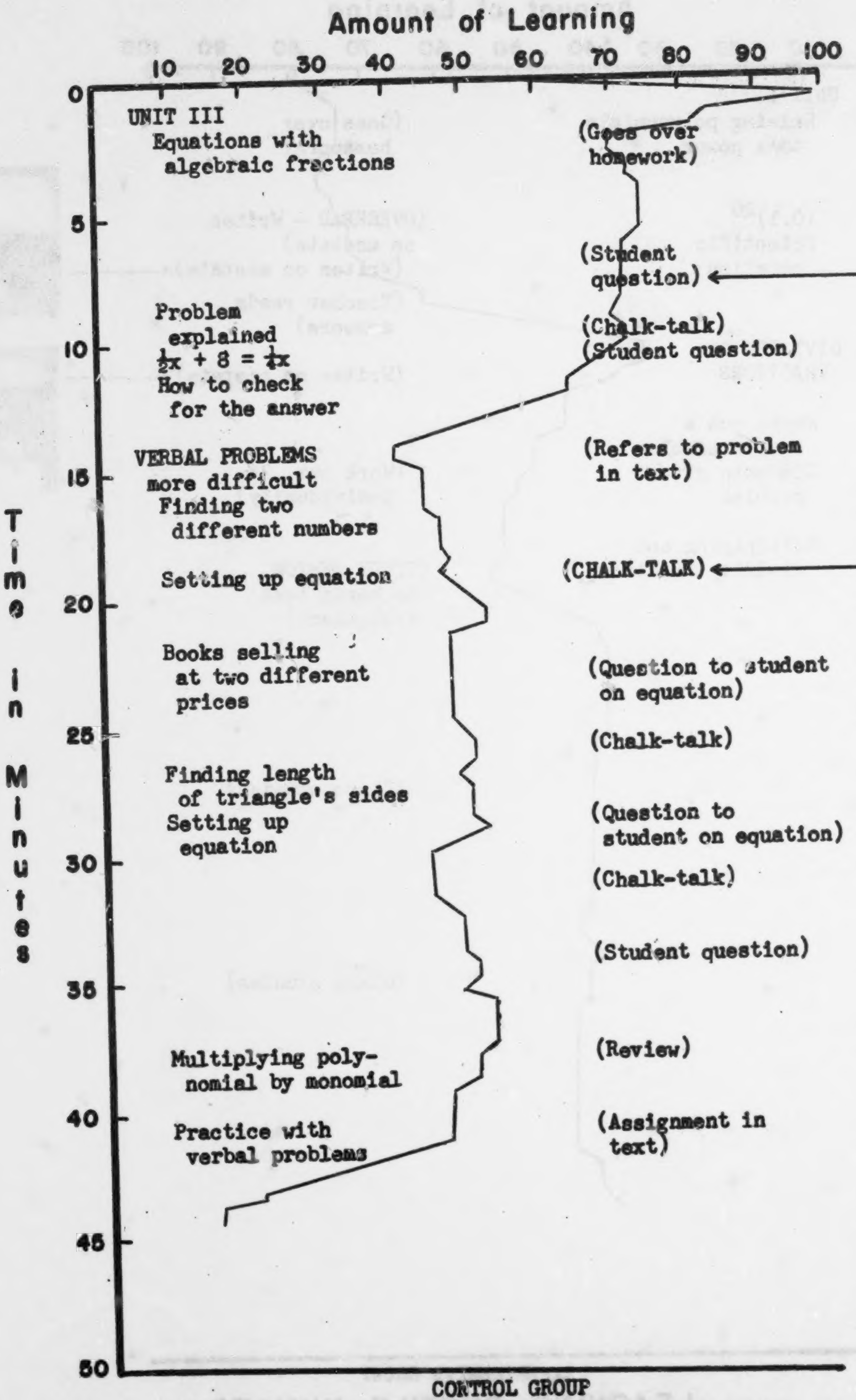
CONTROL GROUP

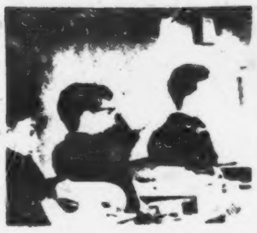
LEARNING PROFILE NUMBER 71



EXPERIMENTAL GROUP

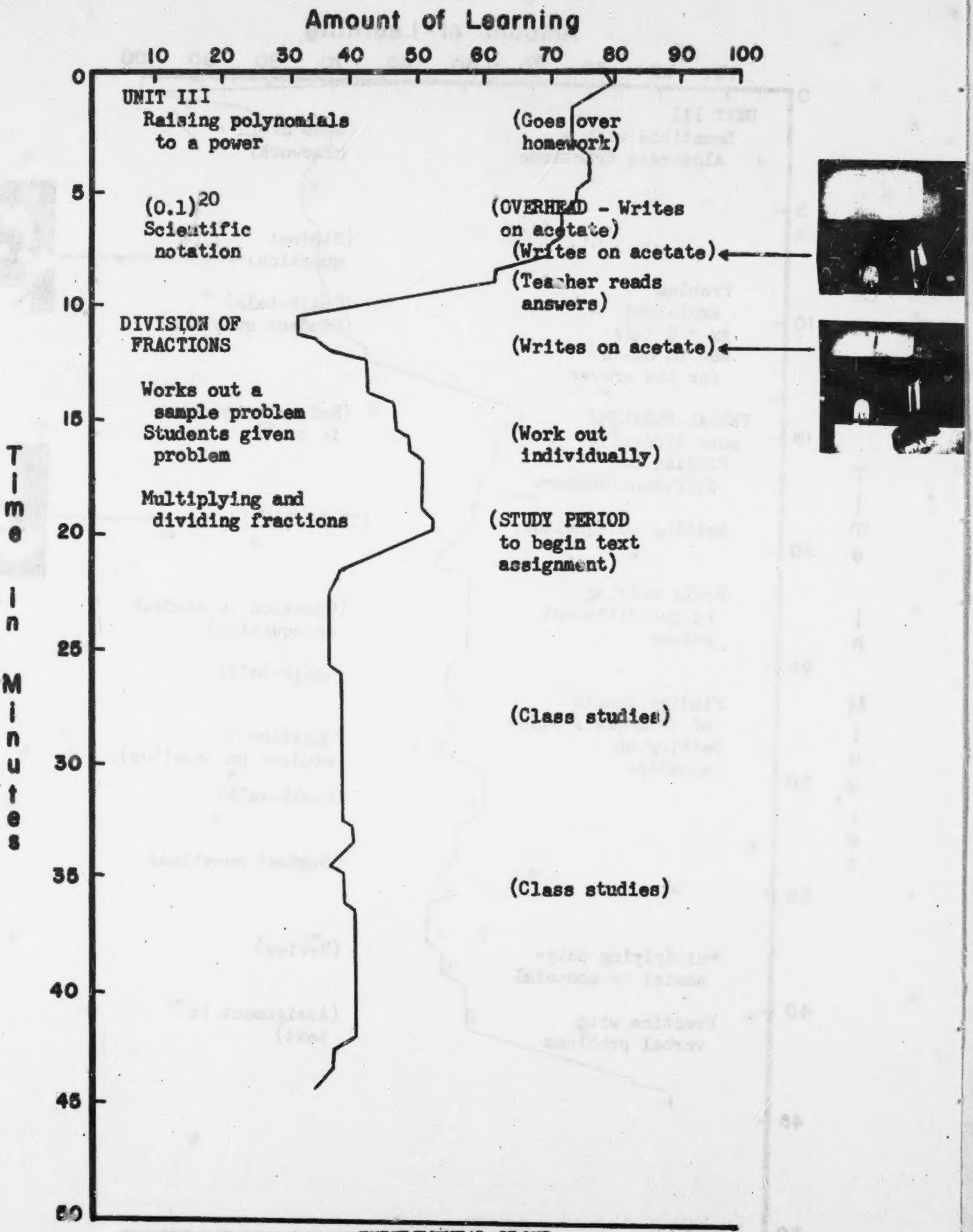
LEARNING PROFILE NUMBER 72





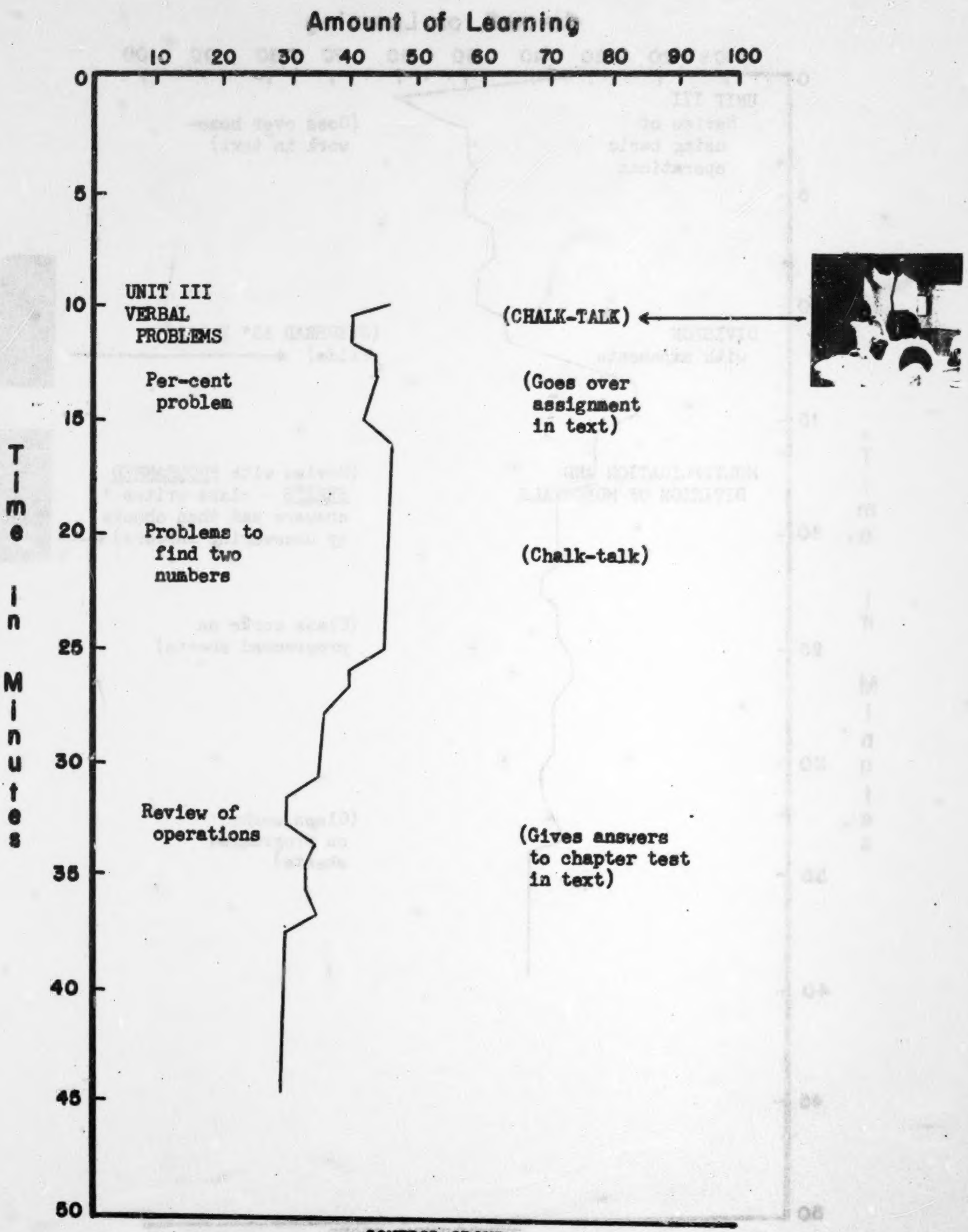
CONTROL GROUP

LEARNING PROFILE NUMBER 73



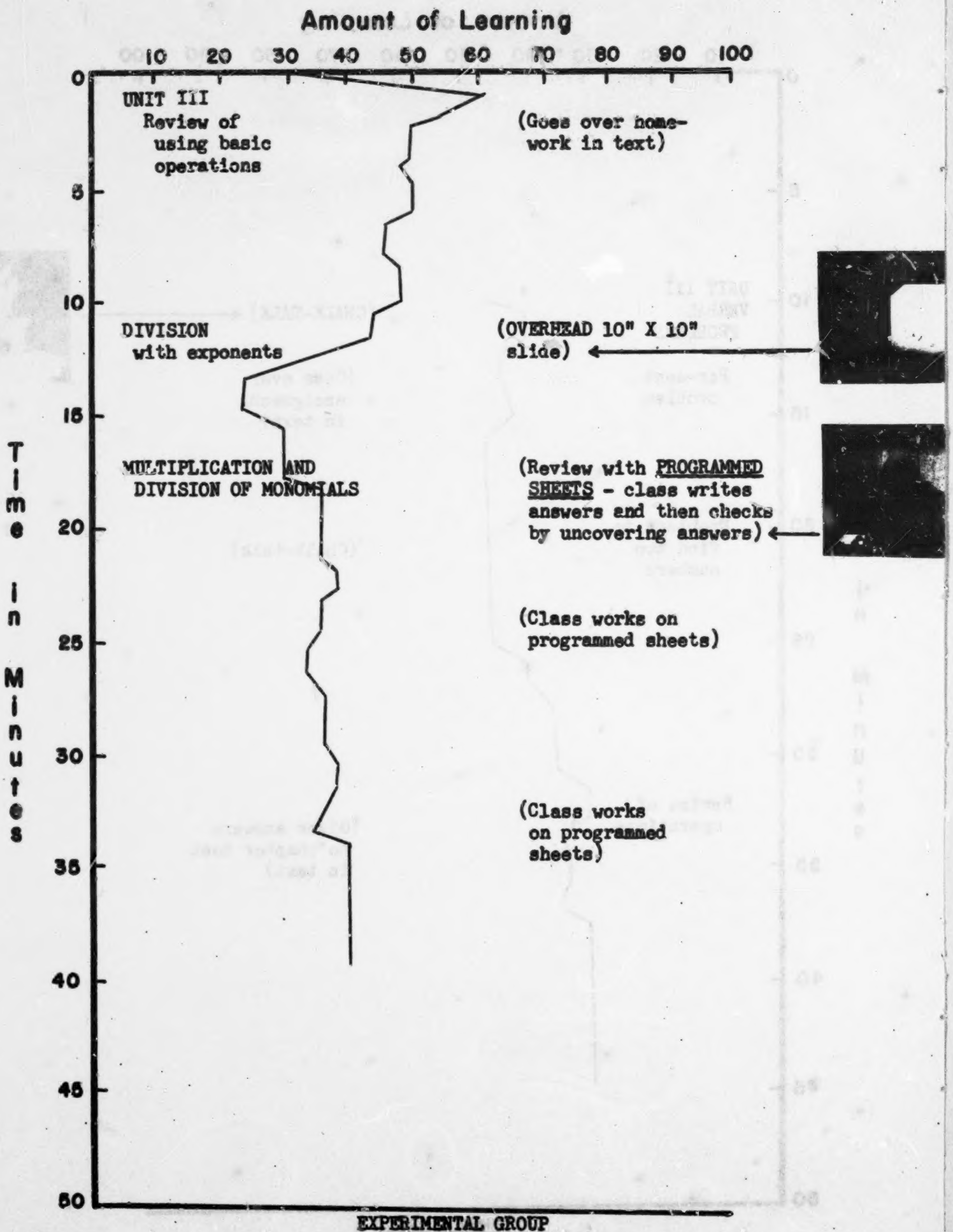
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 74



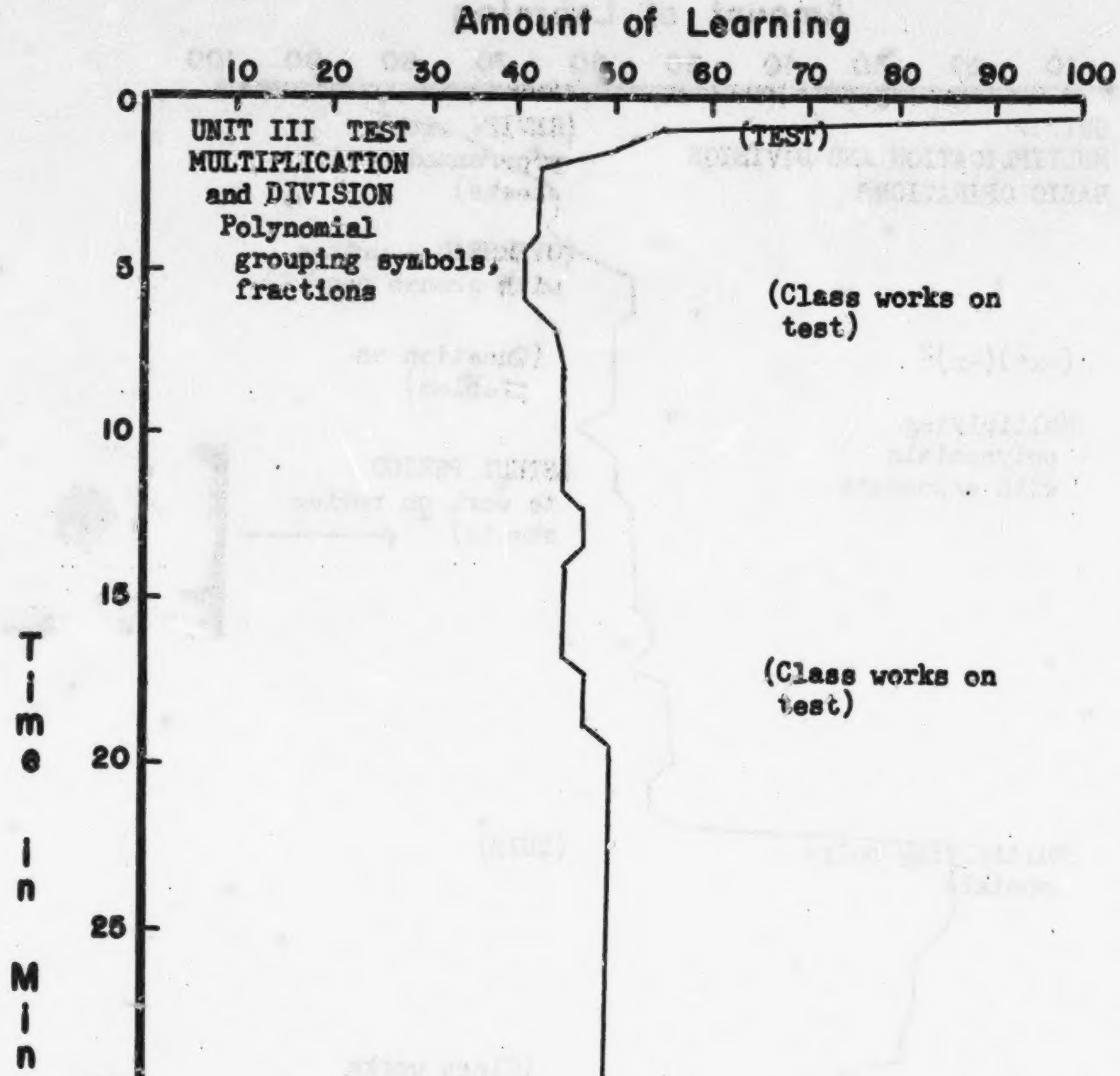
CONTROL GROUP

LEARNING PROFILE NUMBER 75



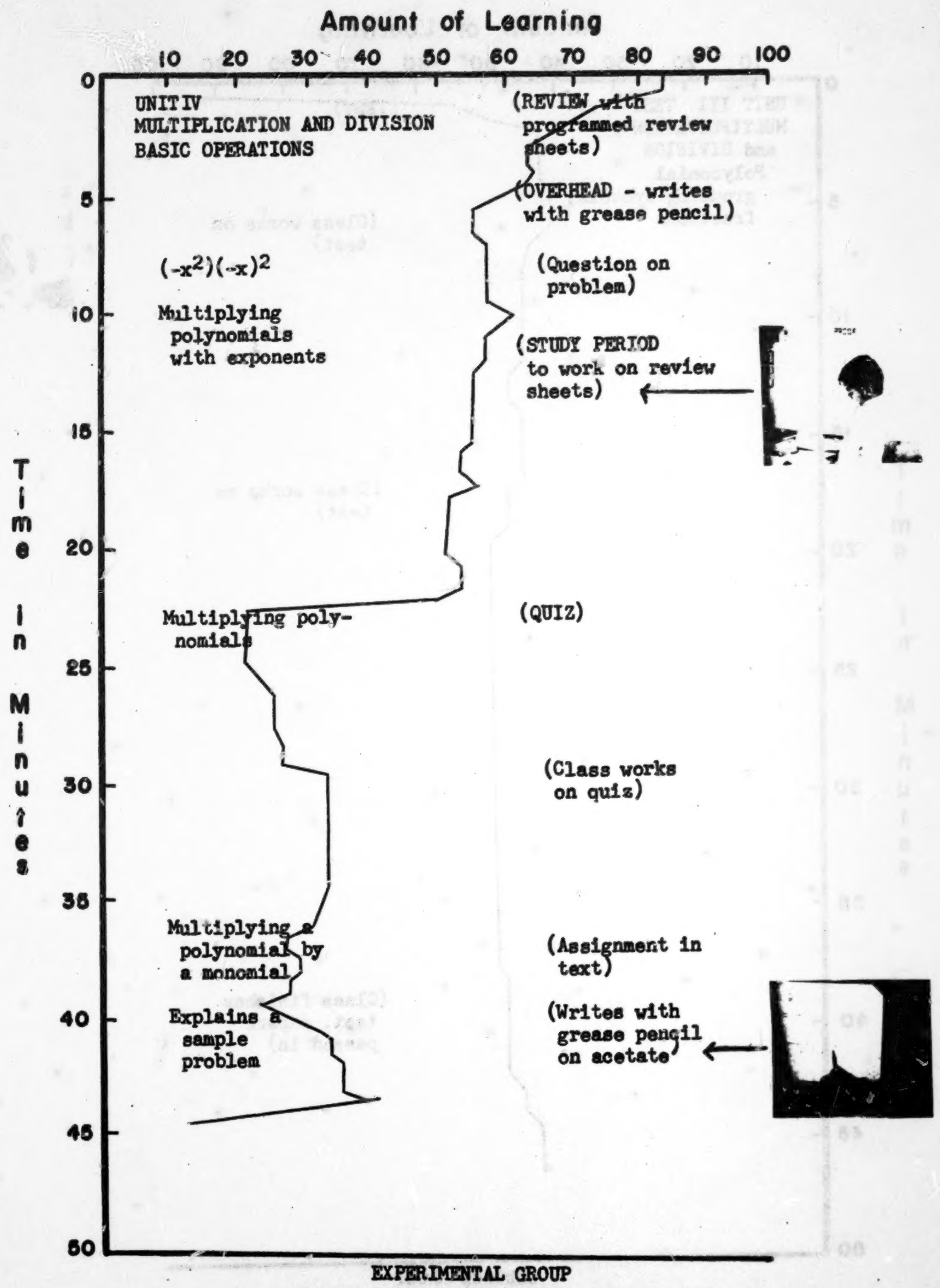
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 76



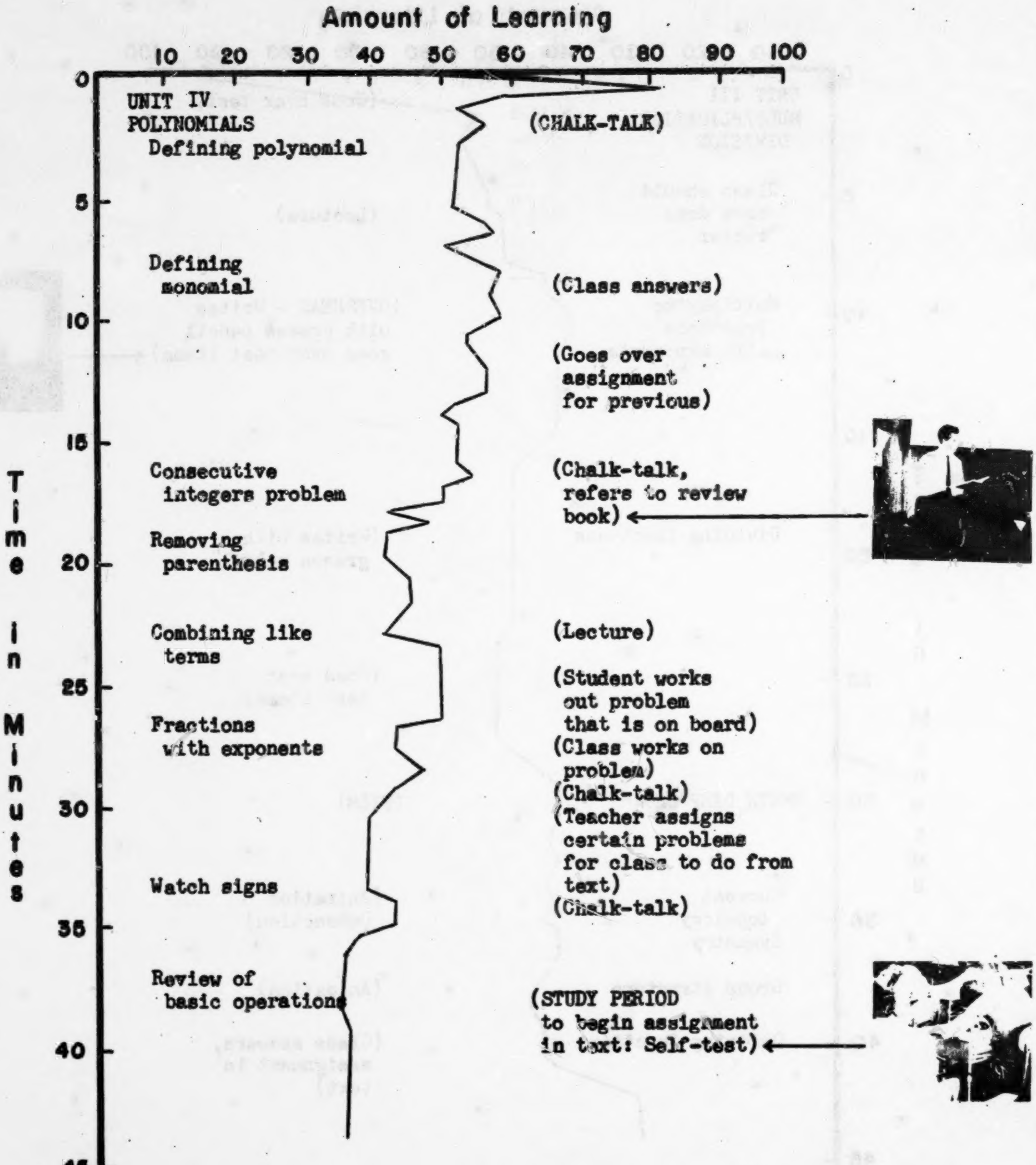
CONTROL GROUP

LEARNING PROFILE NUMBER 77



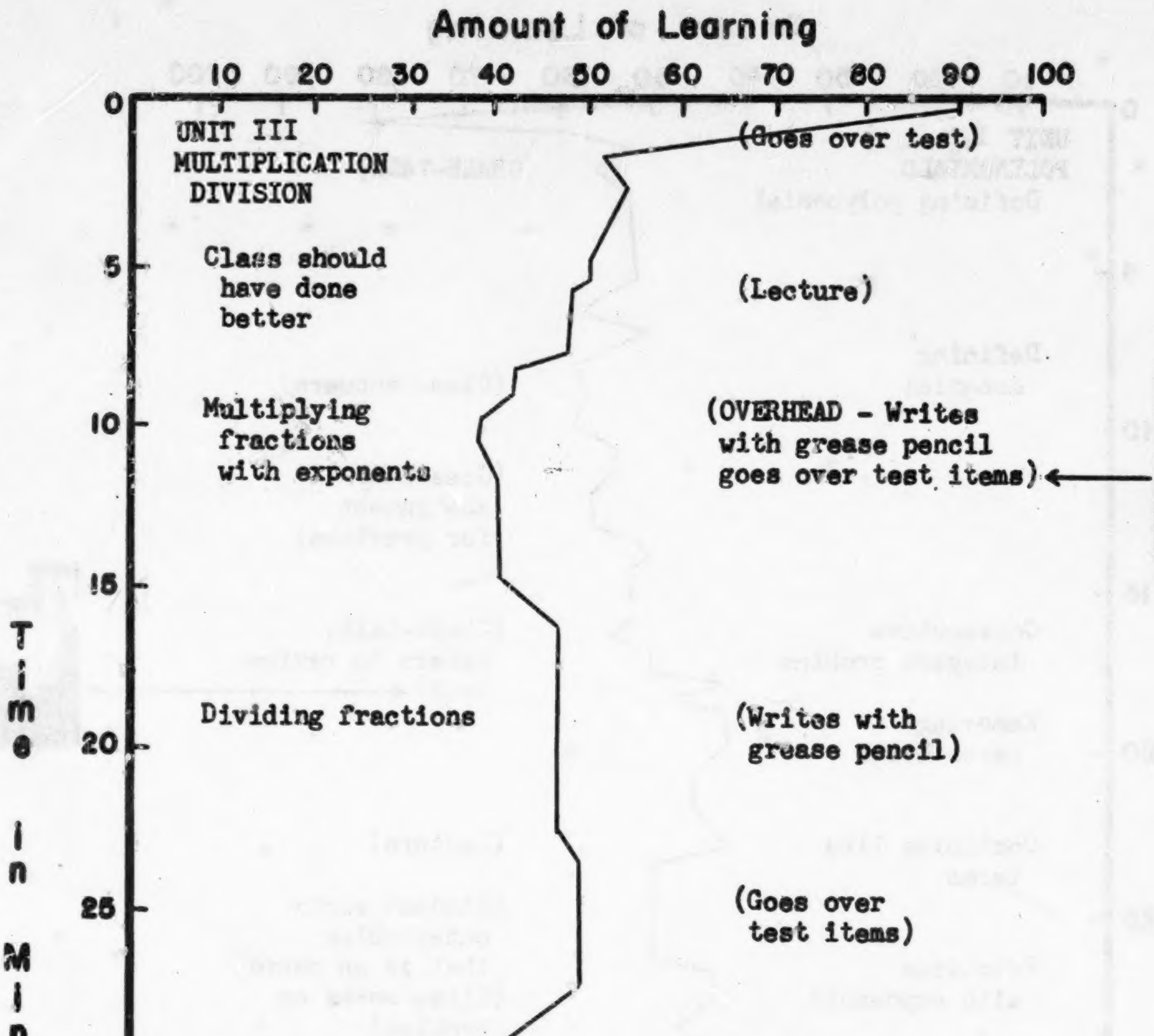
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 78



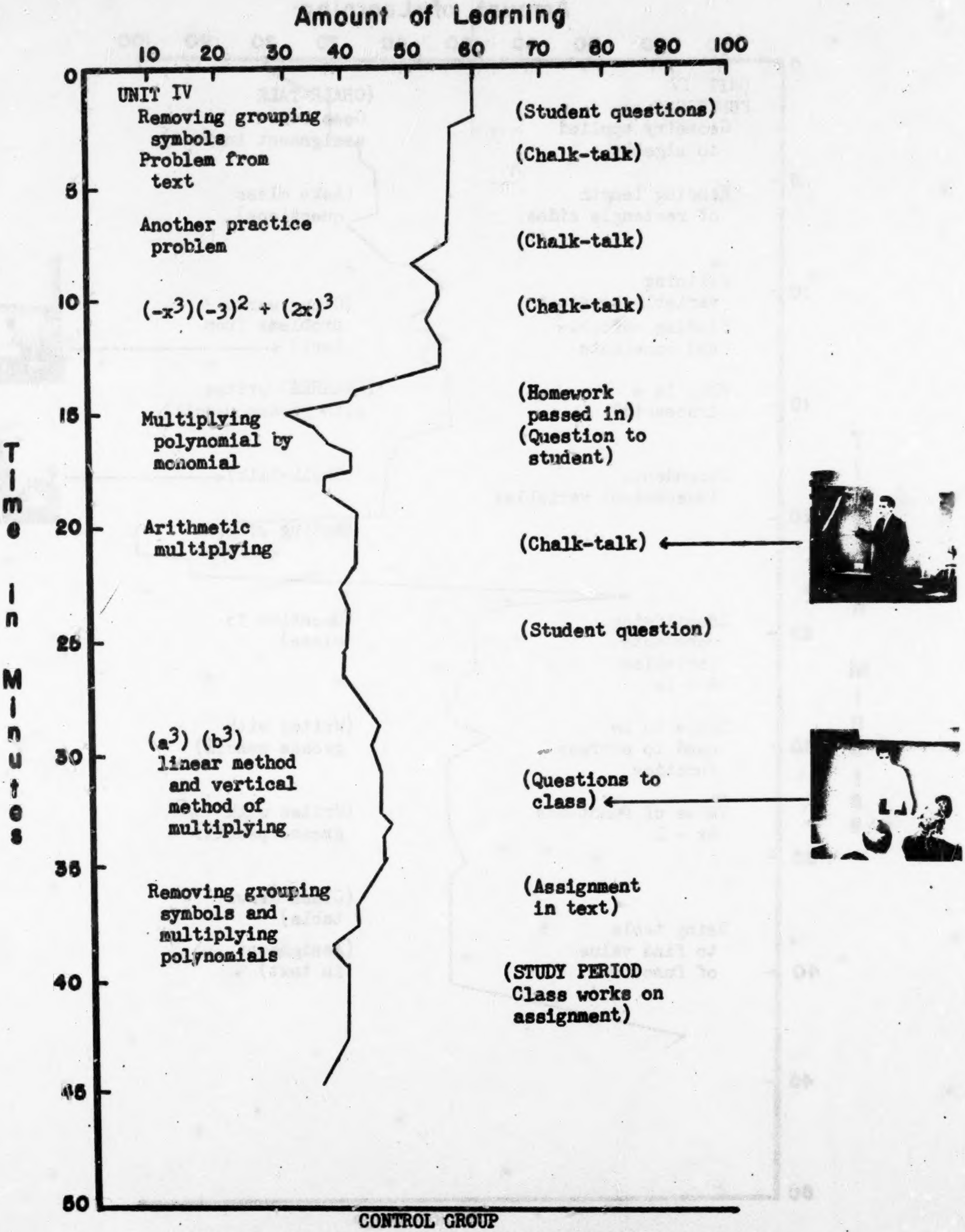
CONTROL GROUP

LEARNING PROFILE NUMBER 79



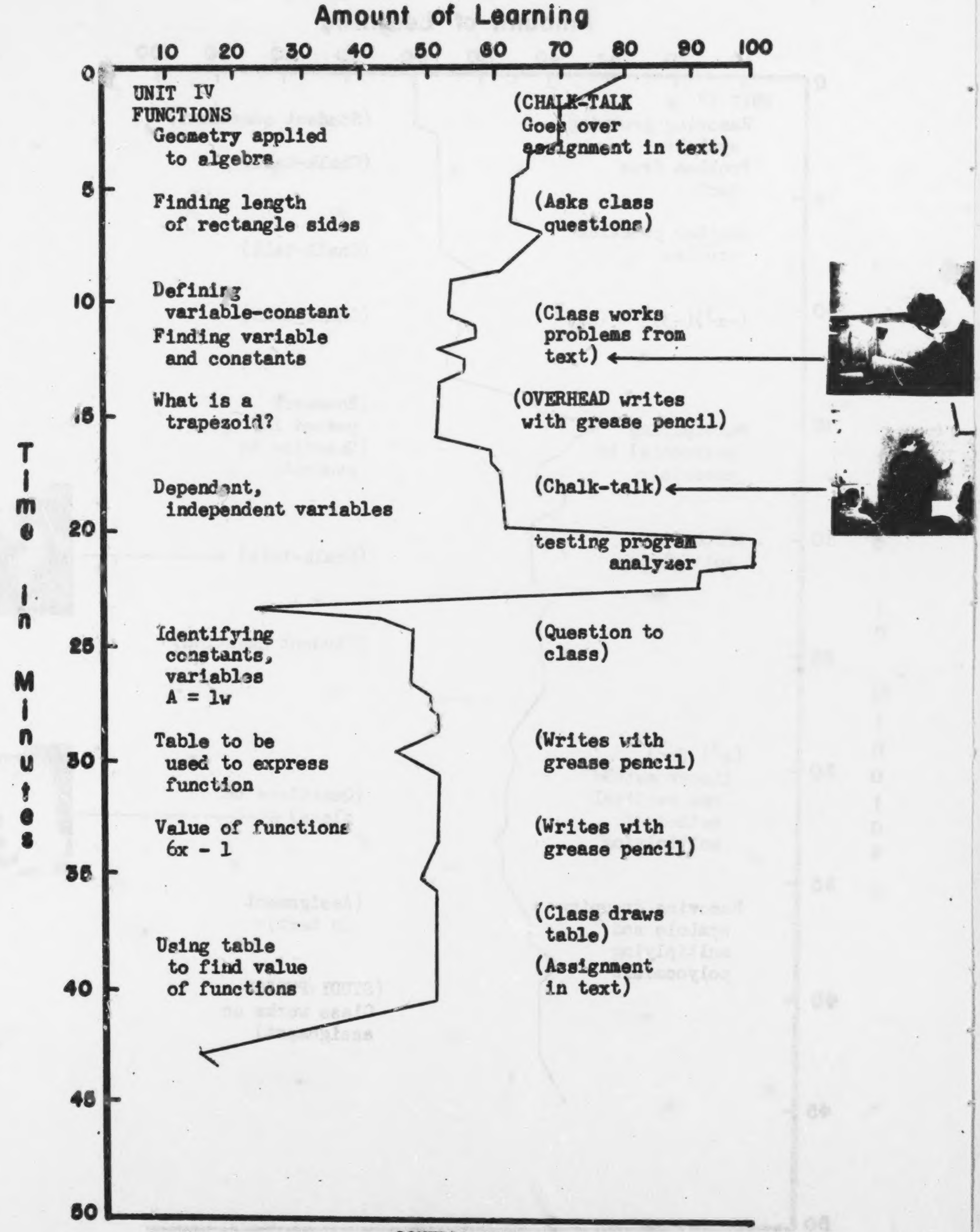
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 80



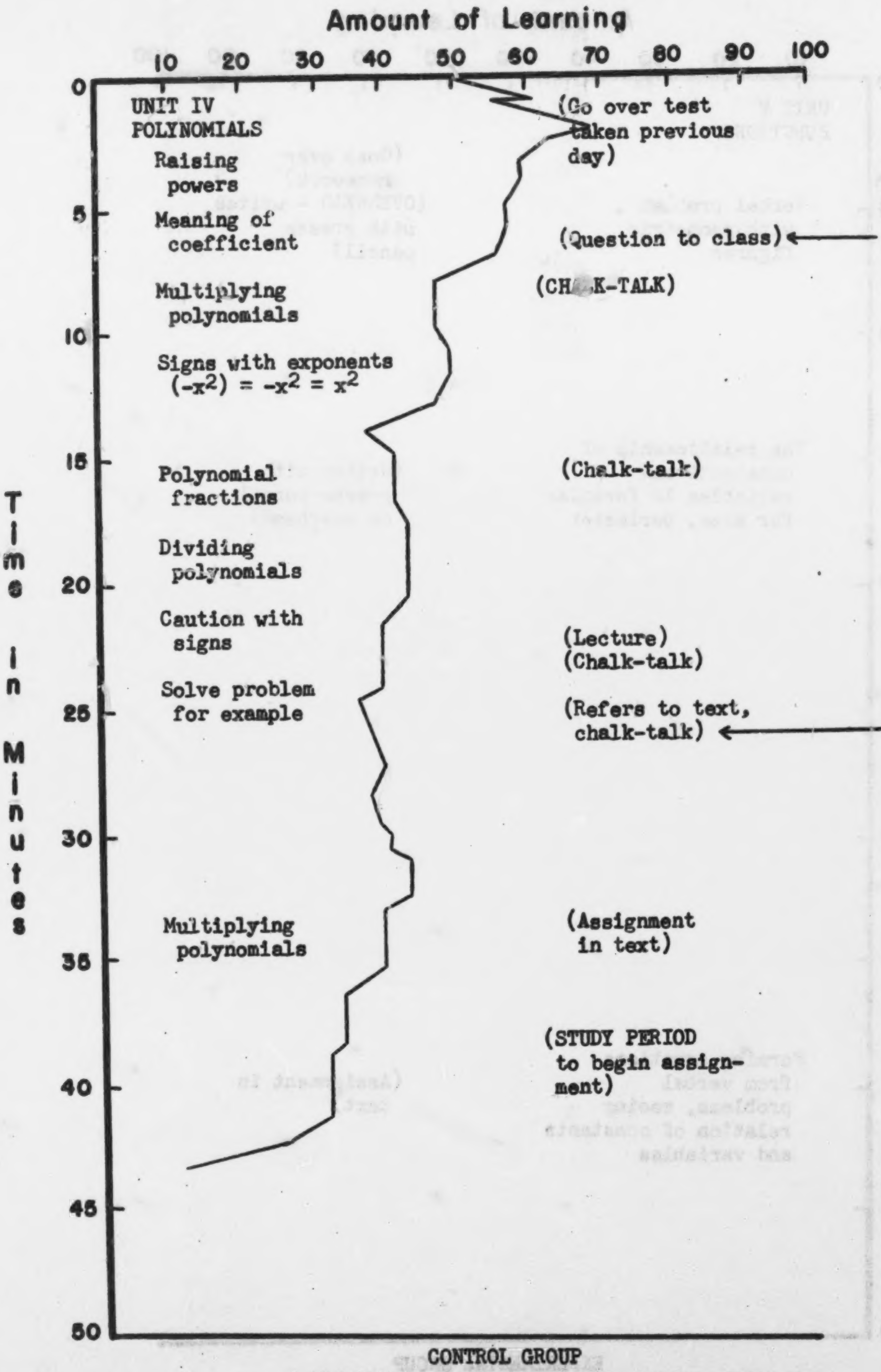
CONTROL GROUP

LEARNING PROFILE NUMBER 81



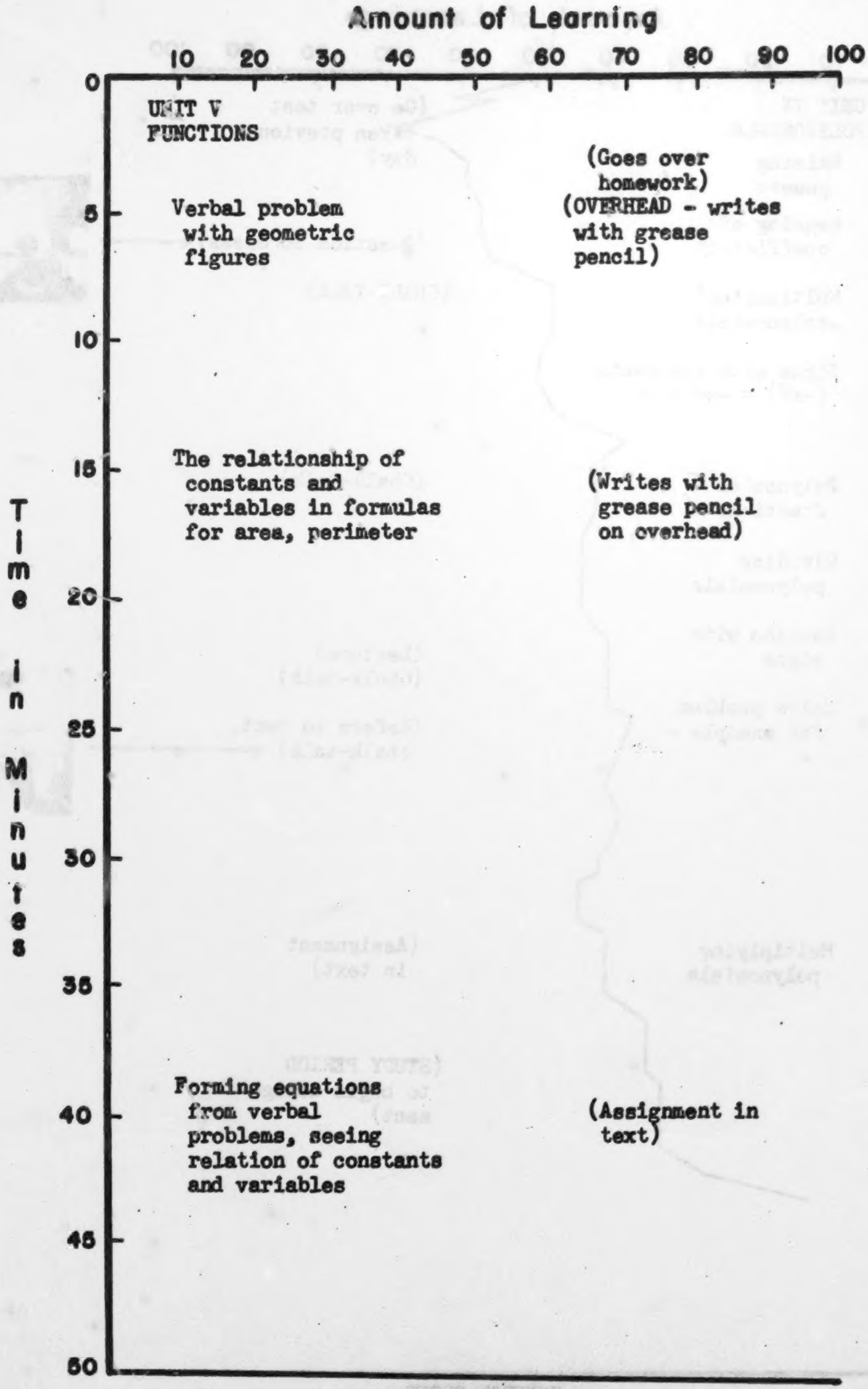
CONTROL GROUP

LEARNING PROFILE NUMBER 82



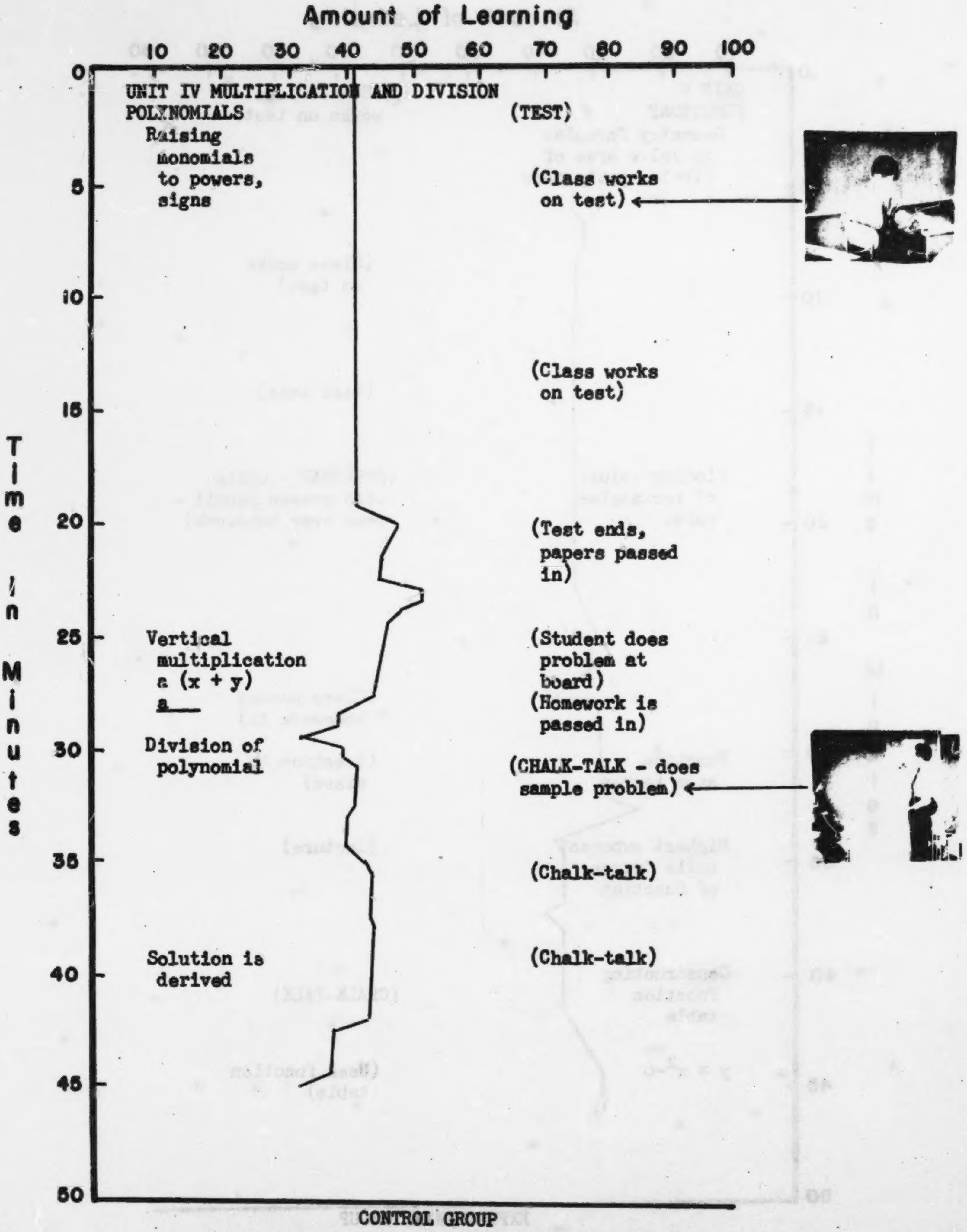
CONTROL GROUP

LEARNING PROFILE NUMBER 83



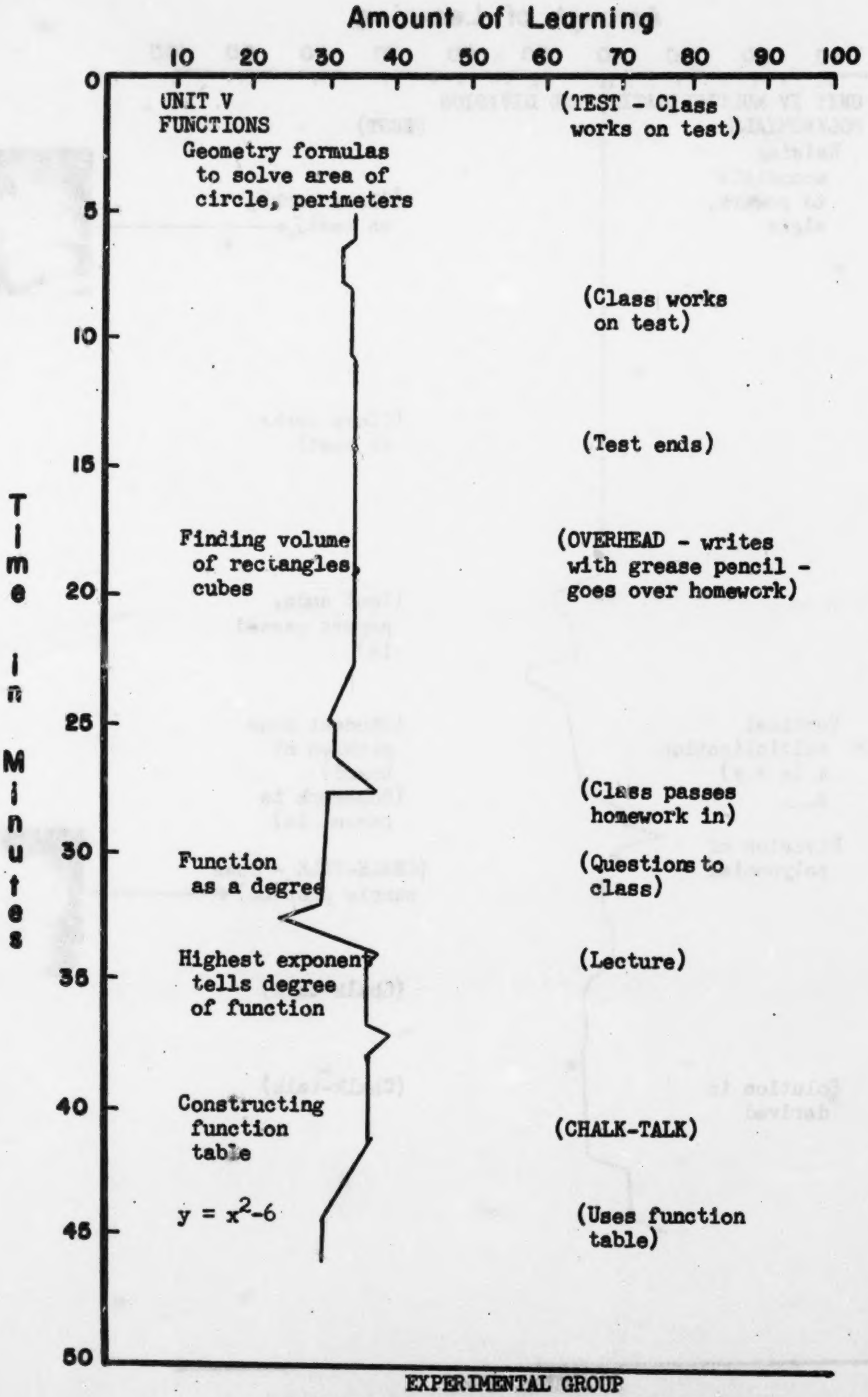
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 84



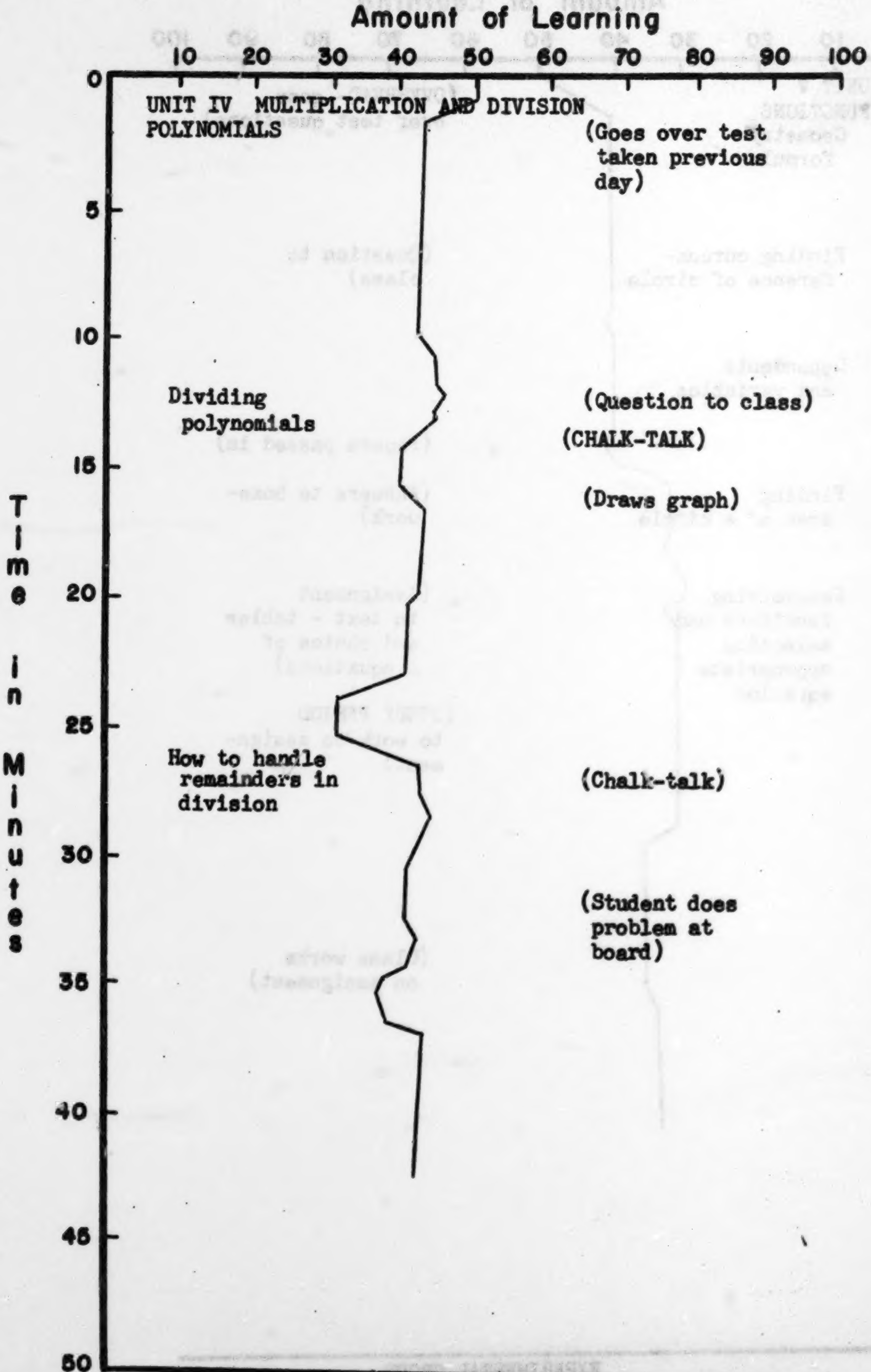
CONTROL GROUP

LEARNING PROFILE NUMBER 85



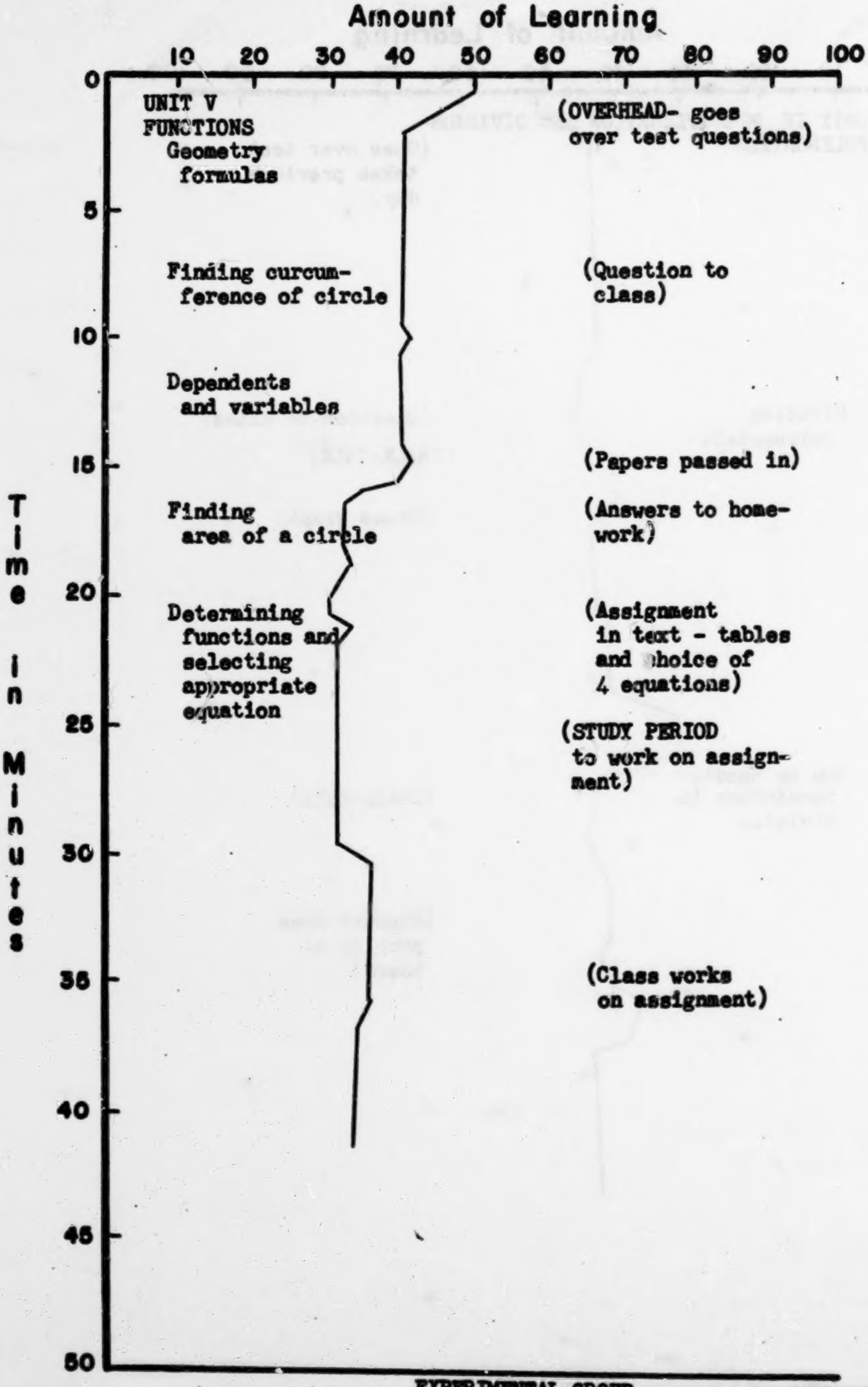
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 86



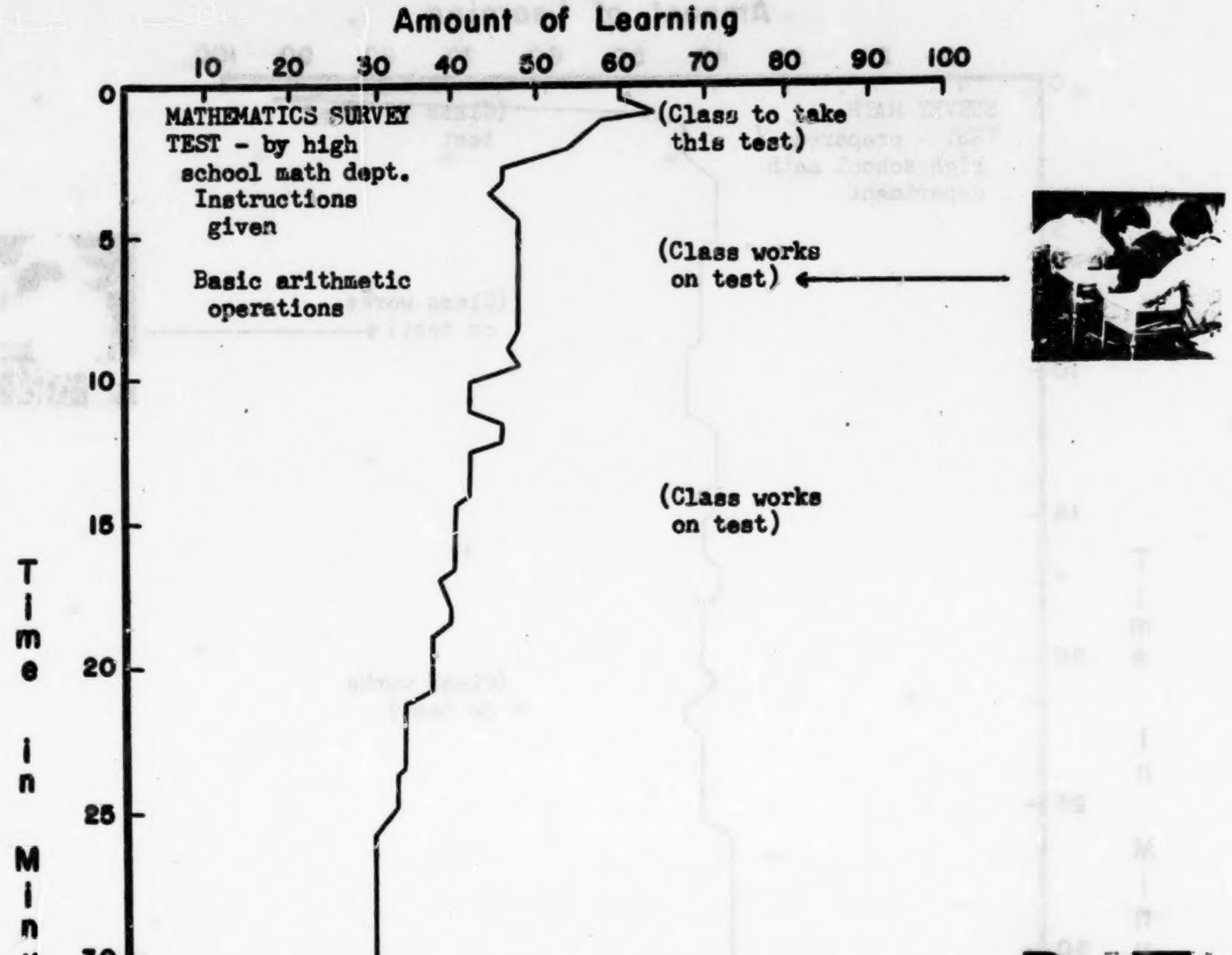
CONTROL GROUP

LEARNING PROFILE NUMBER 87



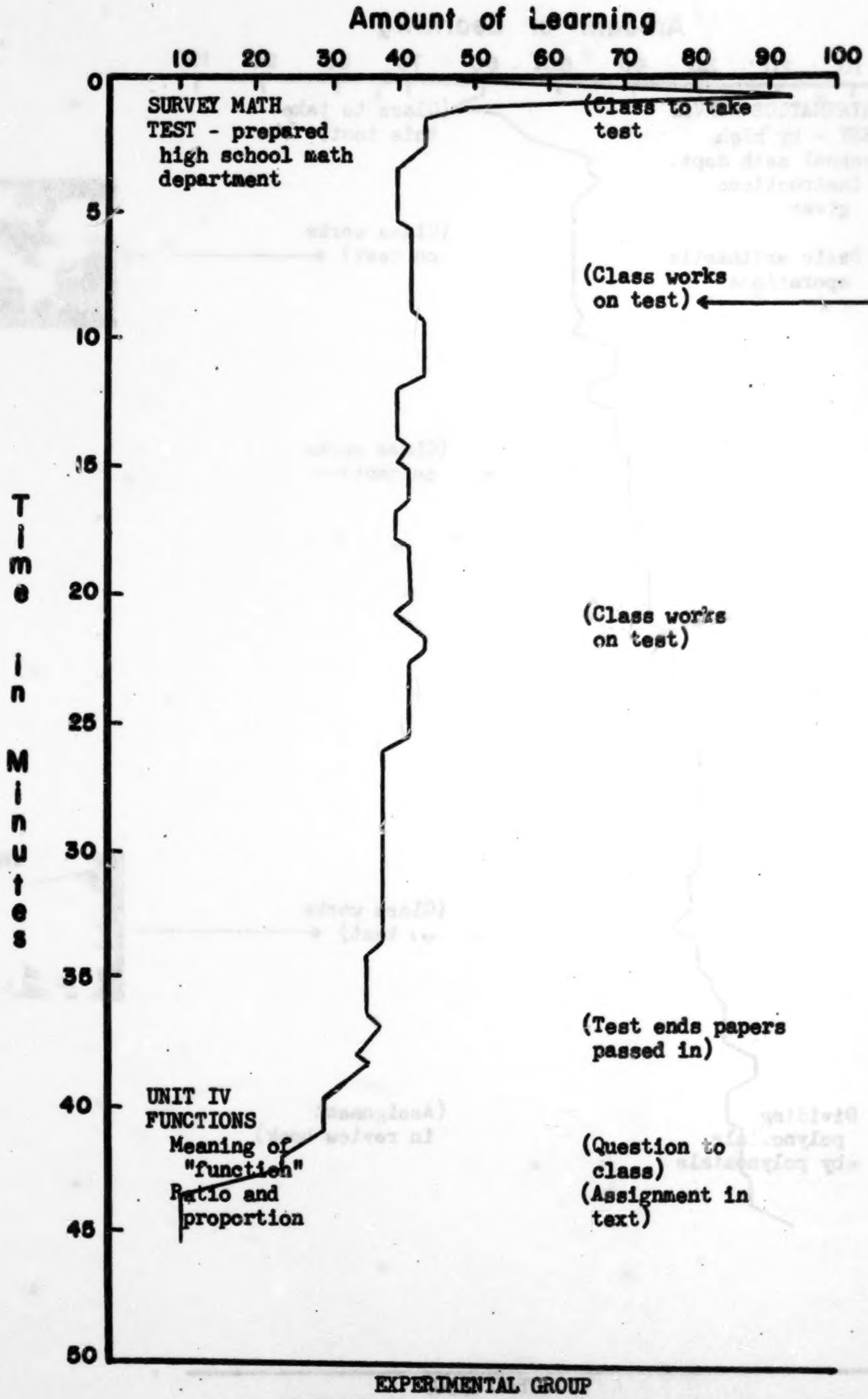
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 88



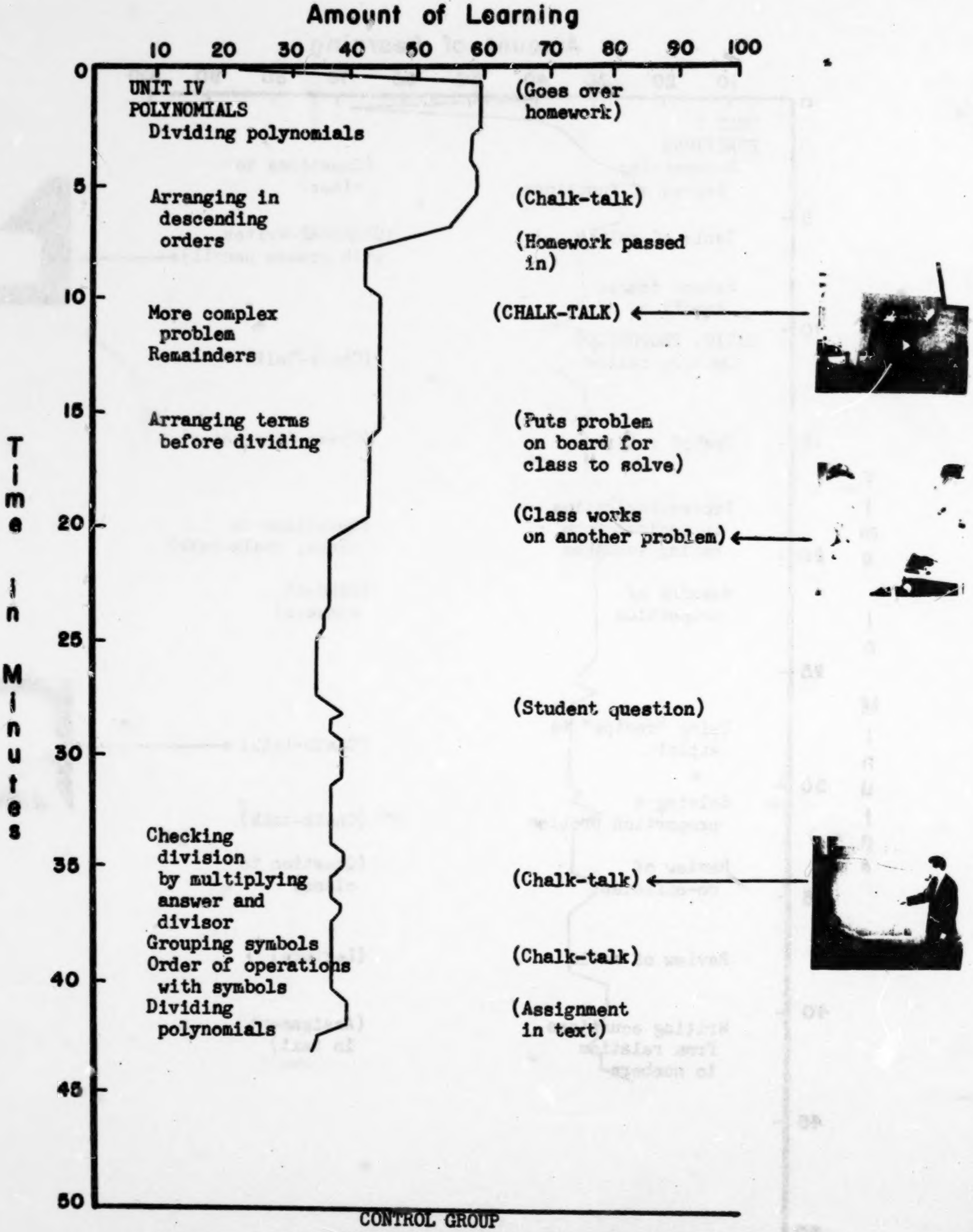
CONTROL GROUP

LEARNING PROFILE NUMBER 89



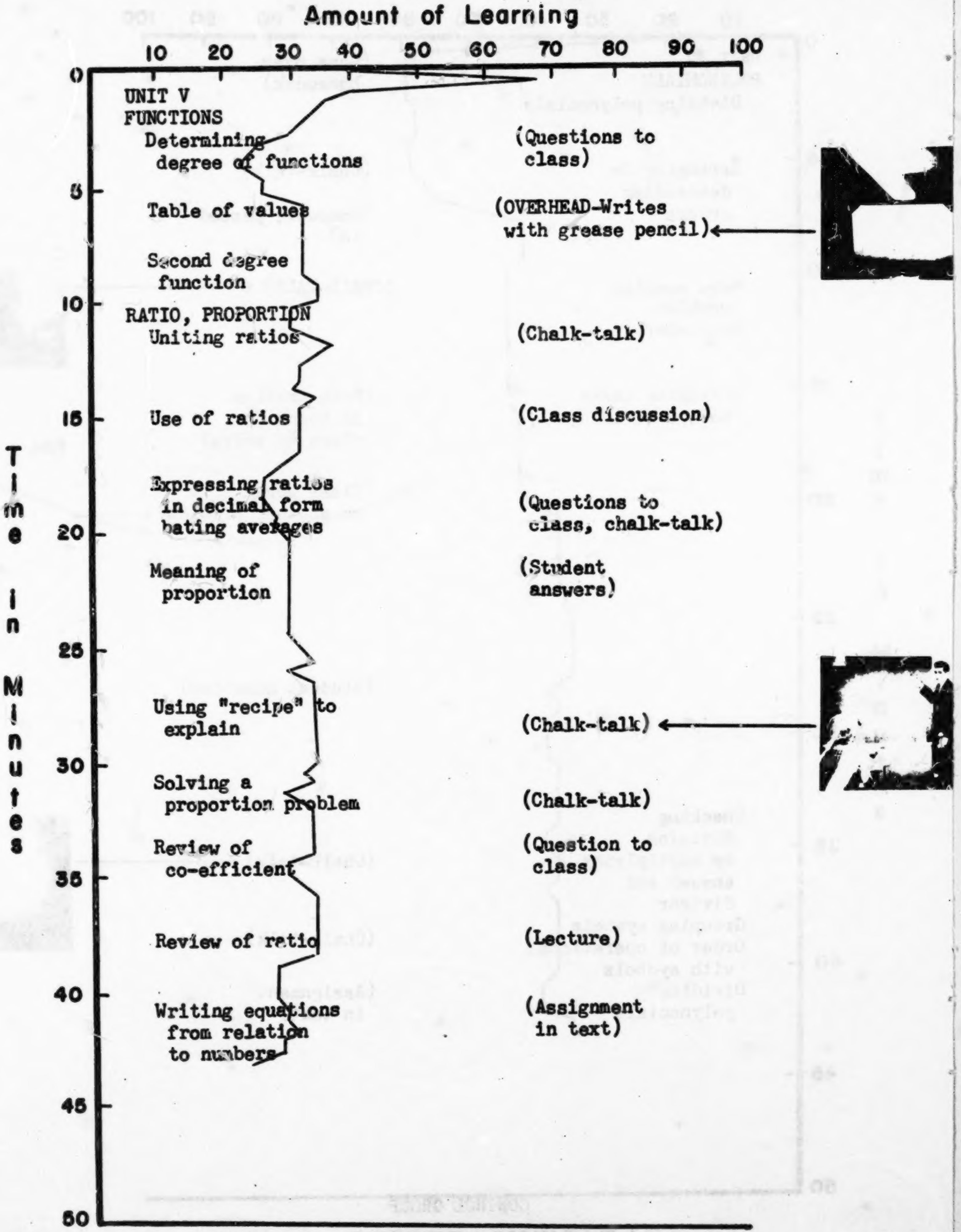
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 90



CONTROL GROUP

LEARNING PROFILE NUMBER 91



EXPERIMENTAL GROUP

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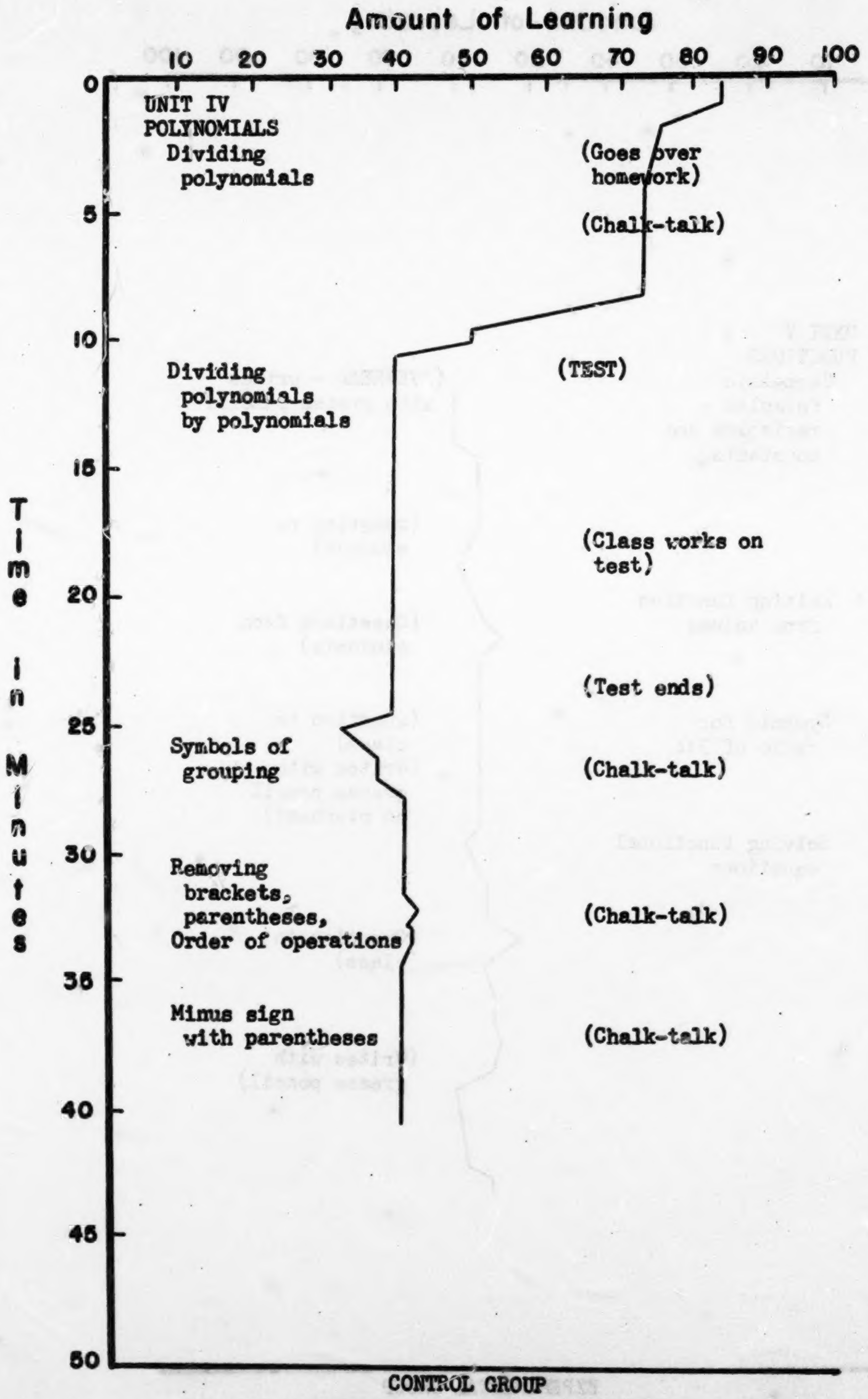
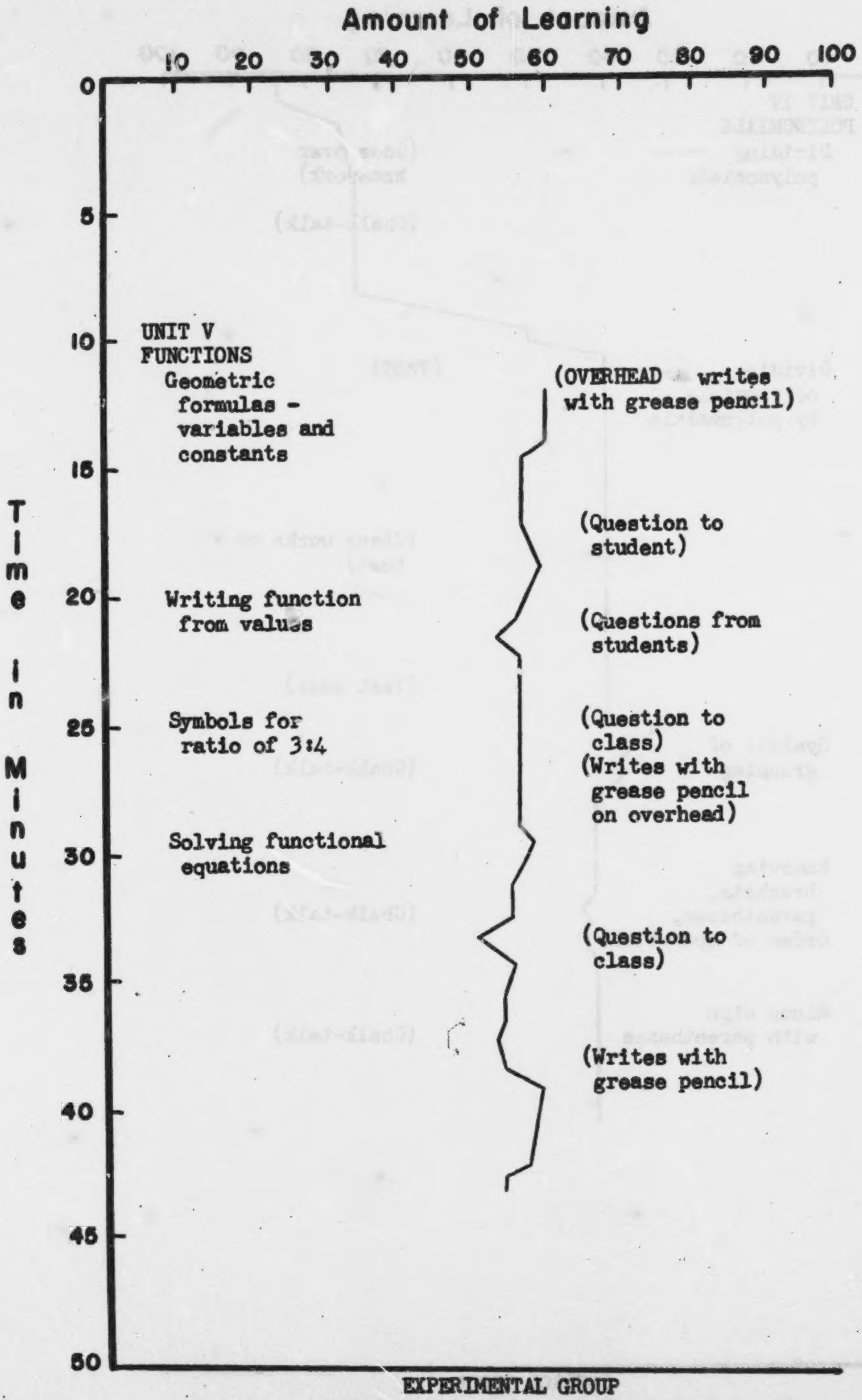


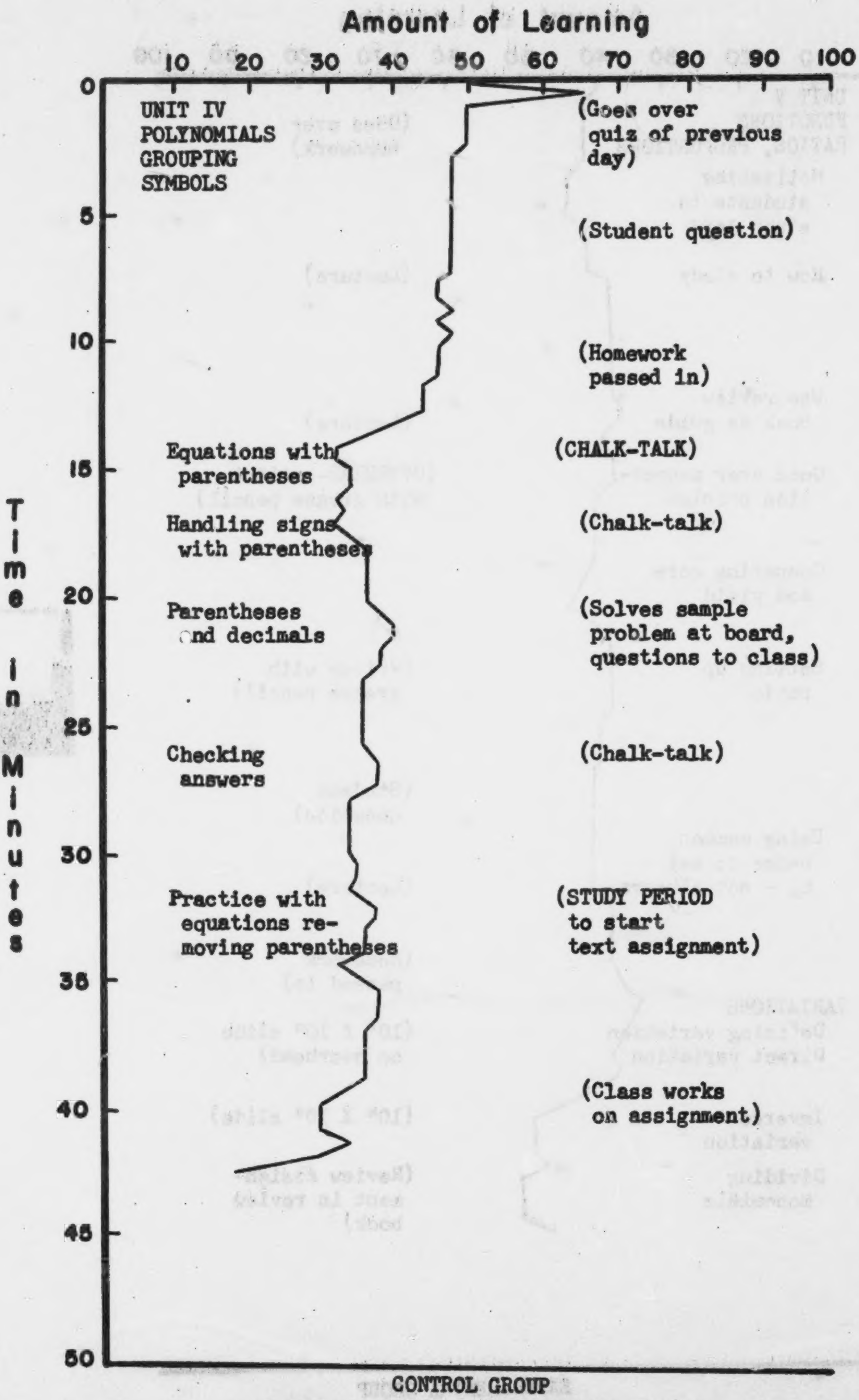
CONTROL GROUP

LEARNING PROFILE NUMBER 93



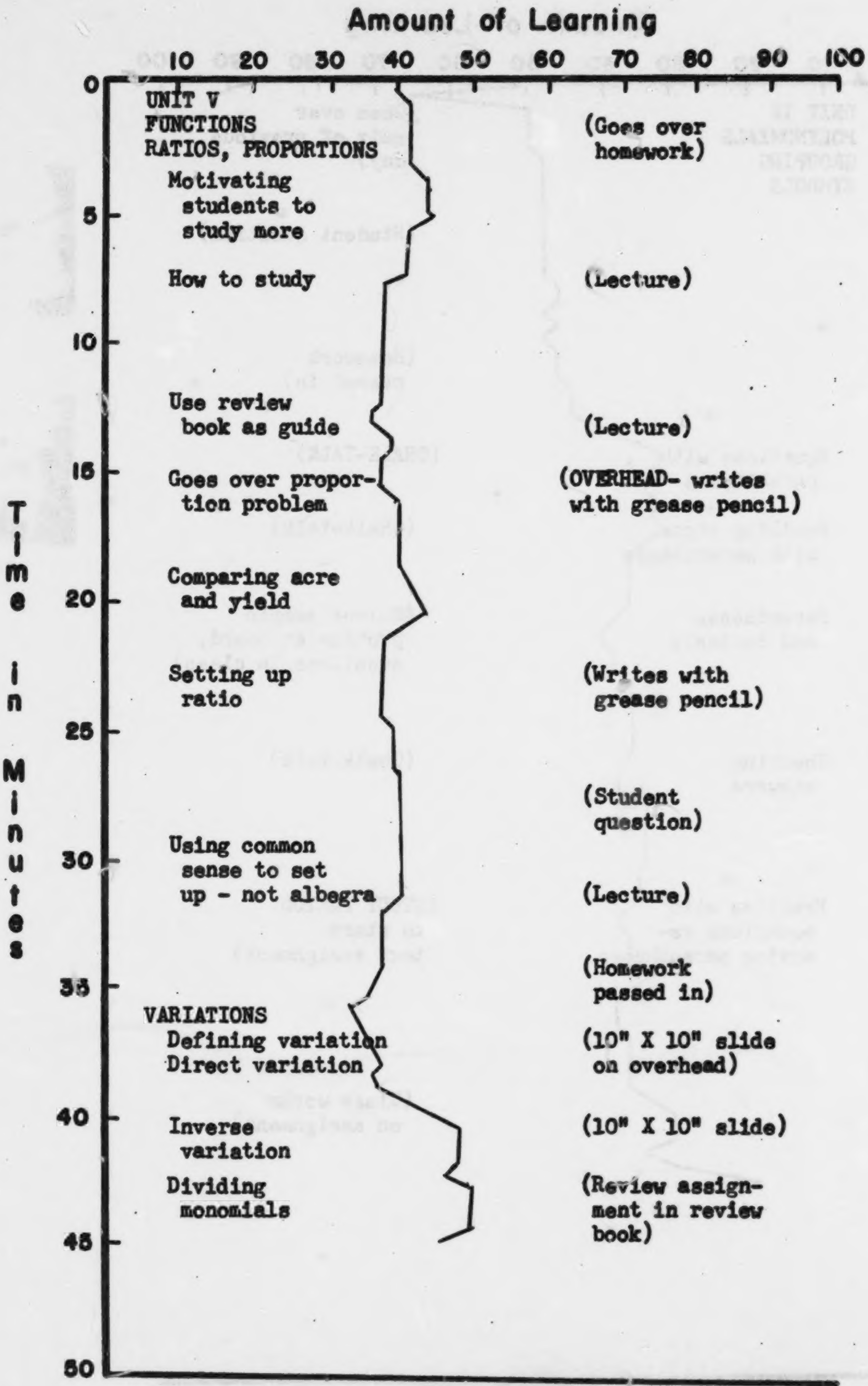
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 94



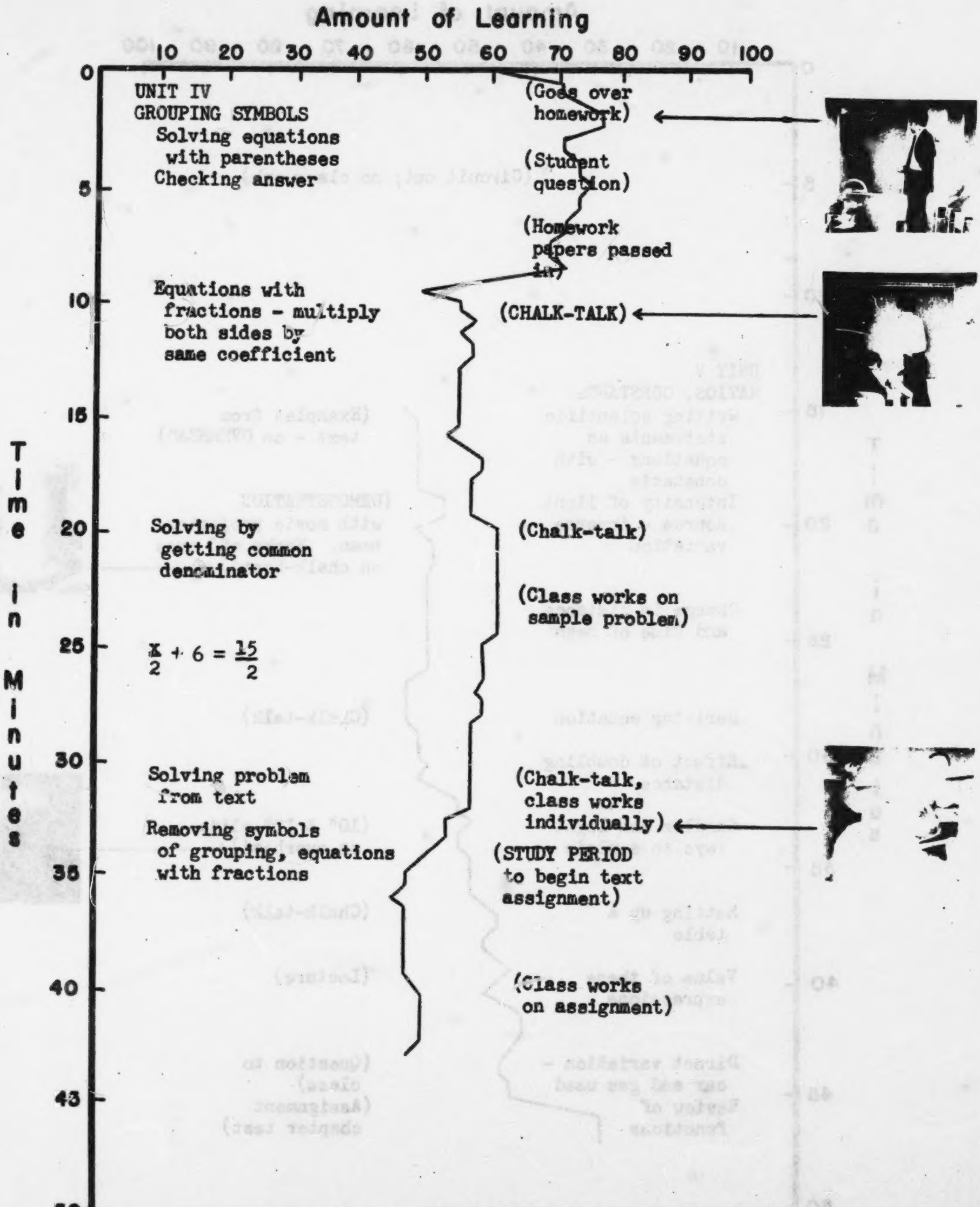
CONTROL GROUP

LEARNING PROFILE NUMBER 95



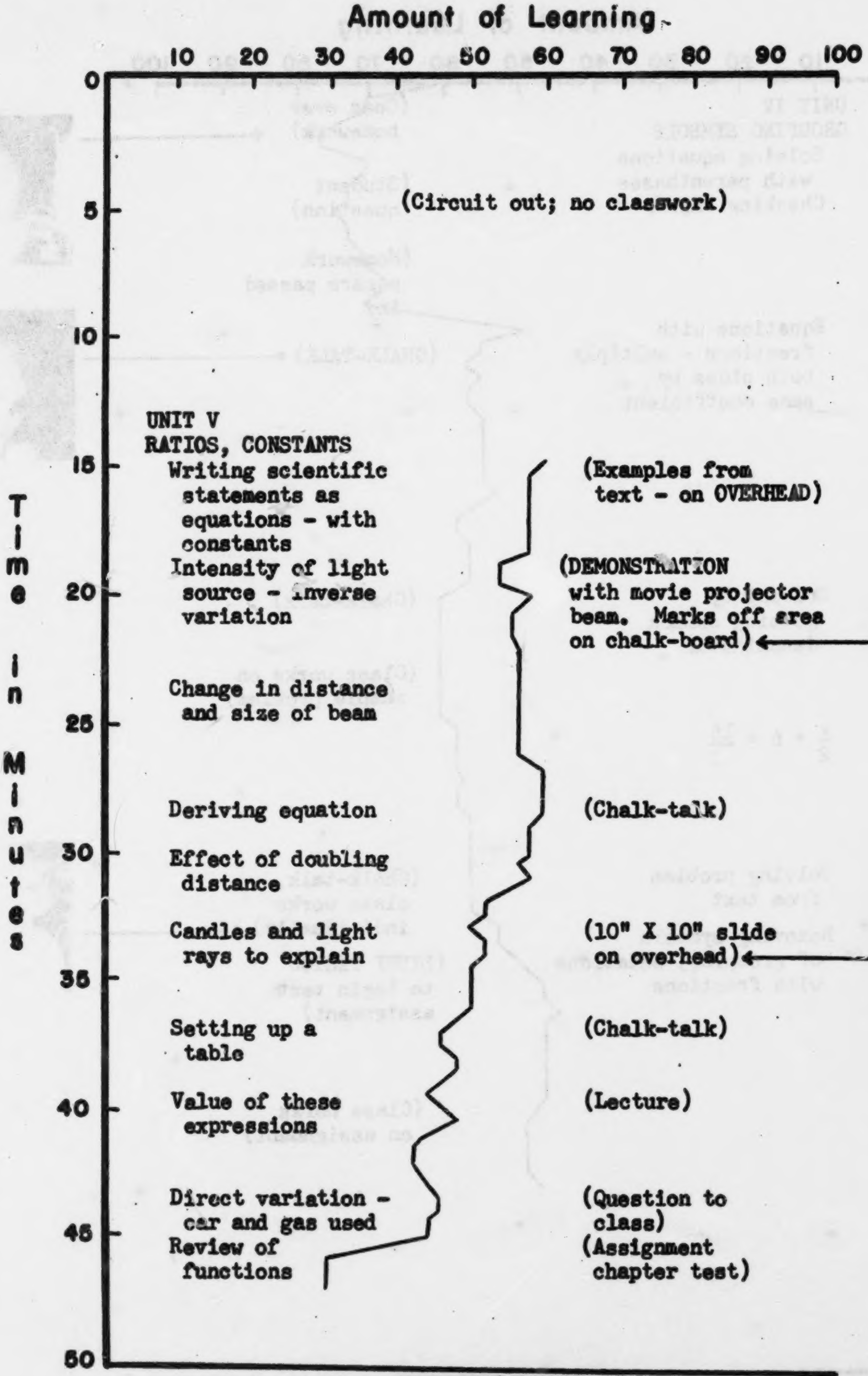
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 96



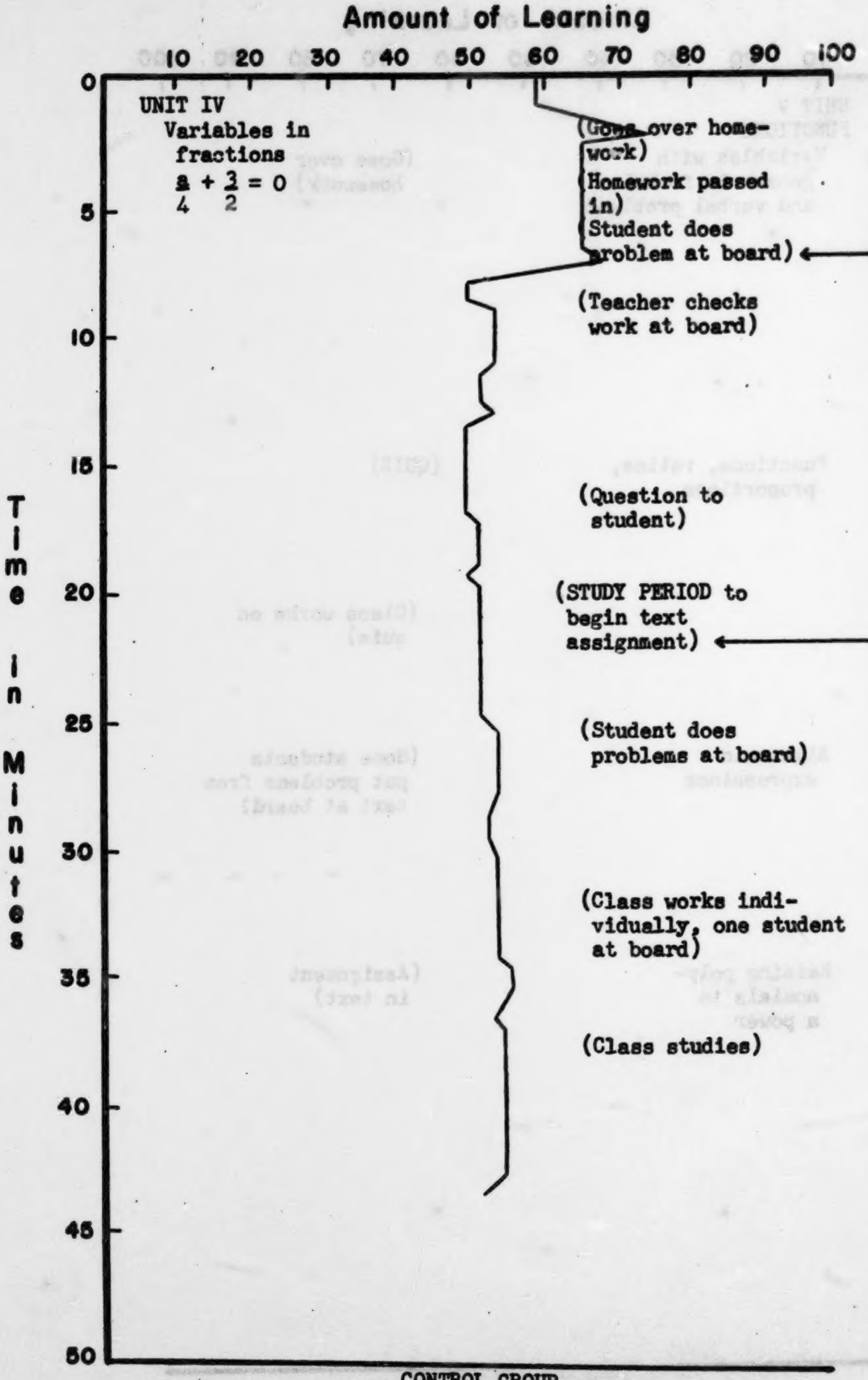
CONTROL GROUP

LEARNING PROFILE NUMBER 97



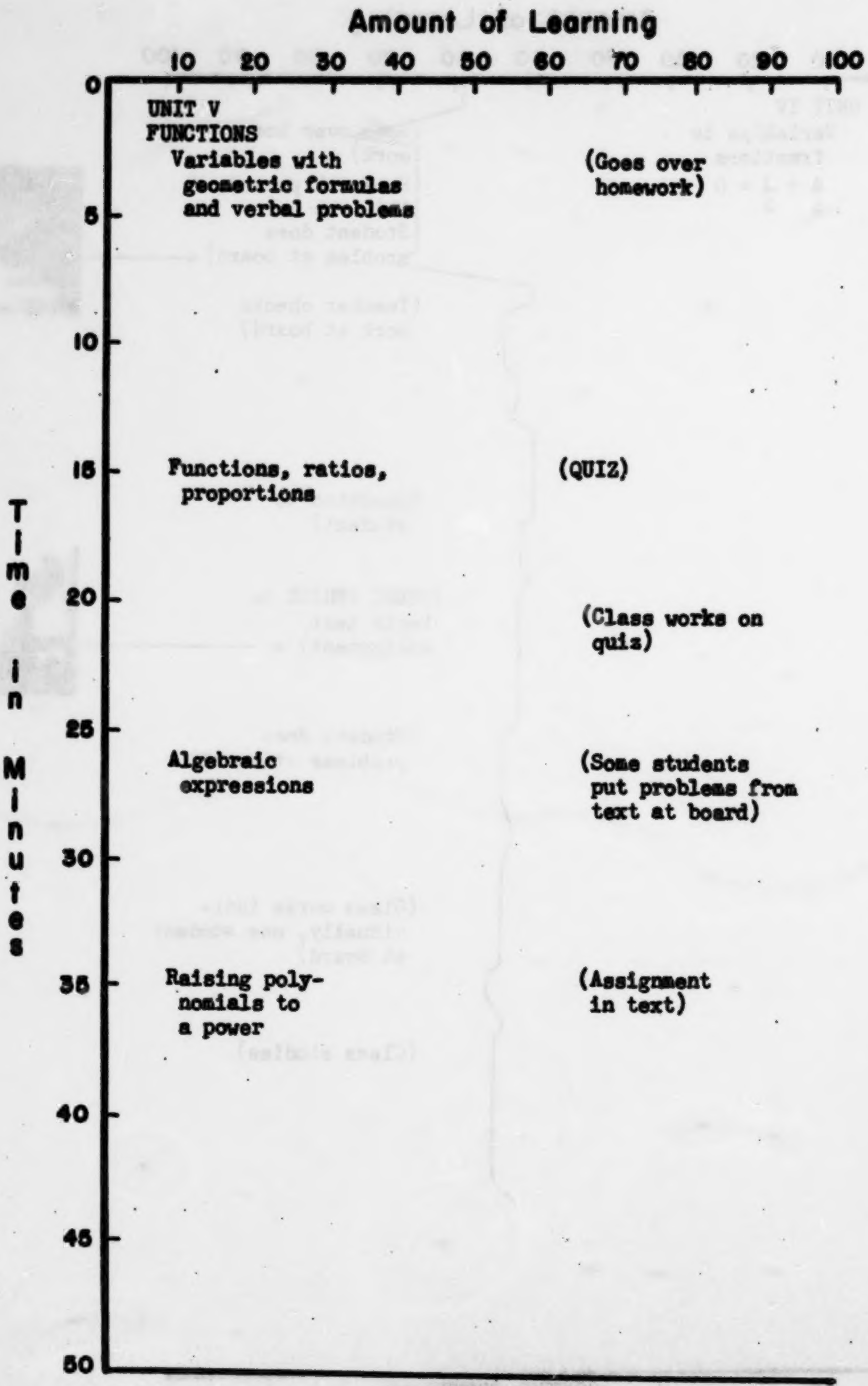
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 98



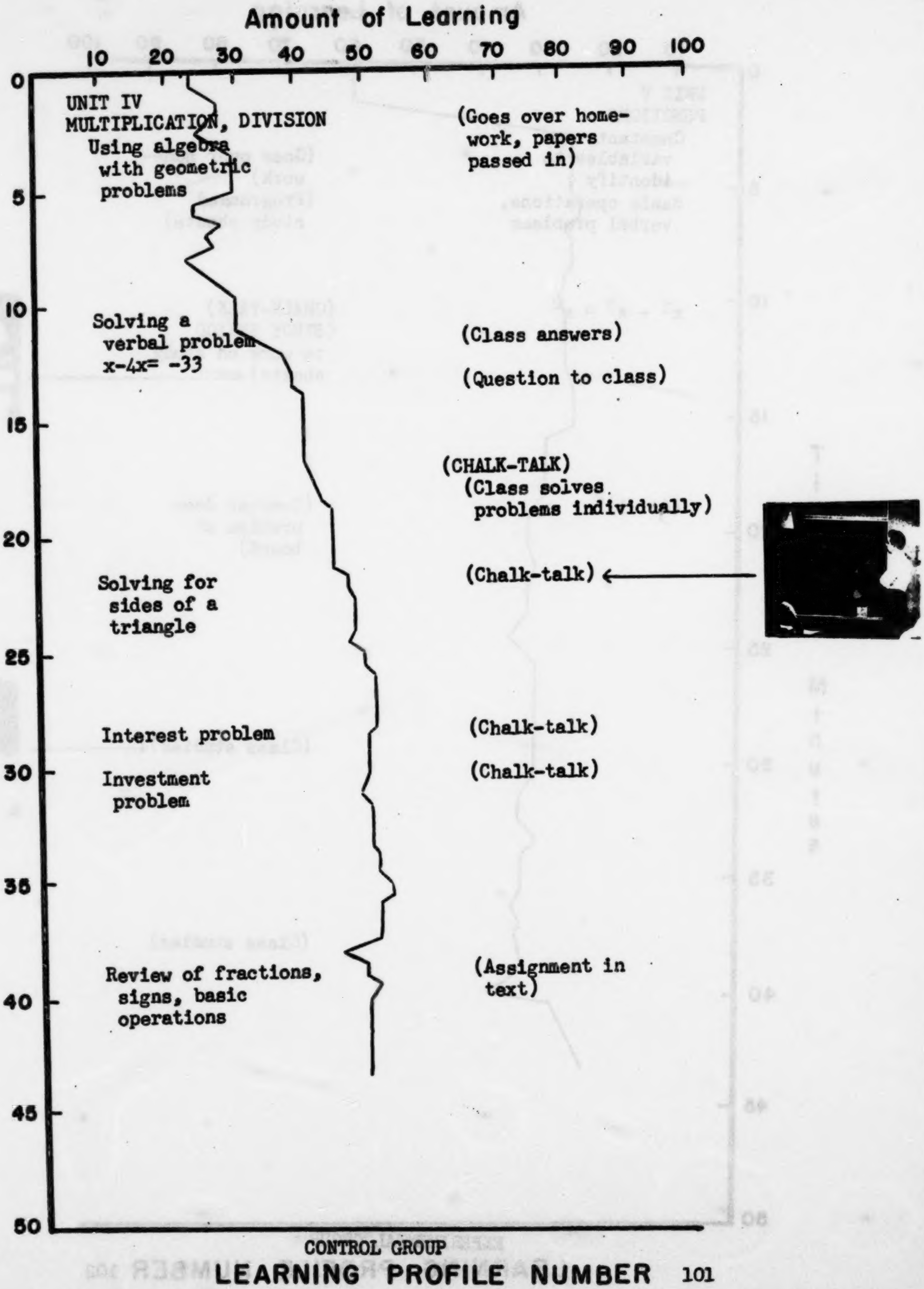
CONTROL GROUP

LEARNING PROFILE NUMBER 99



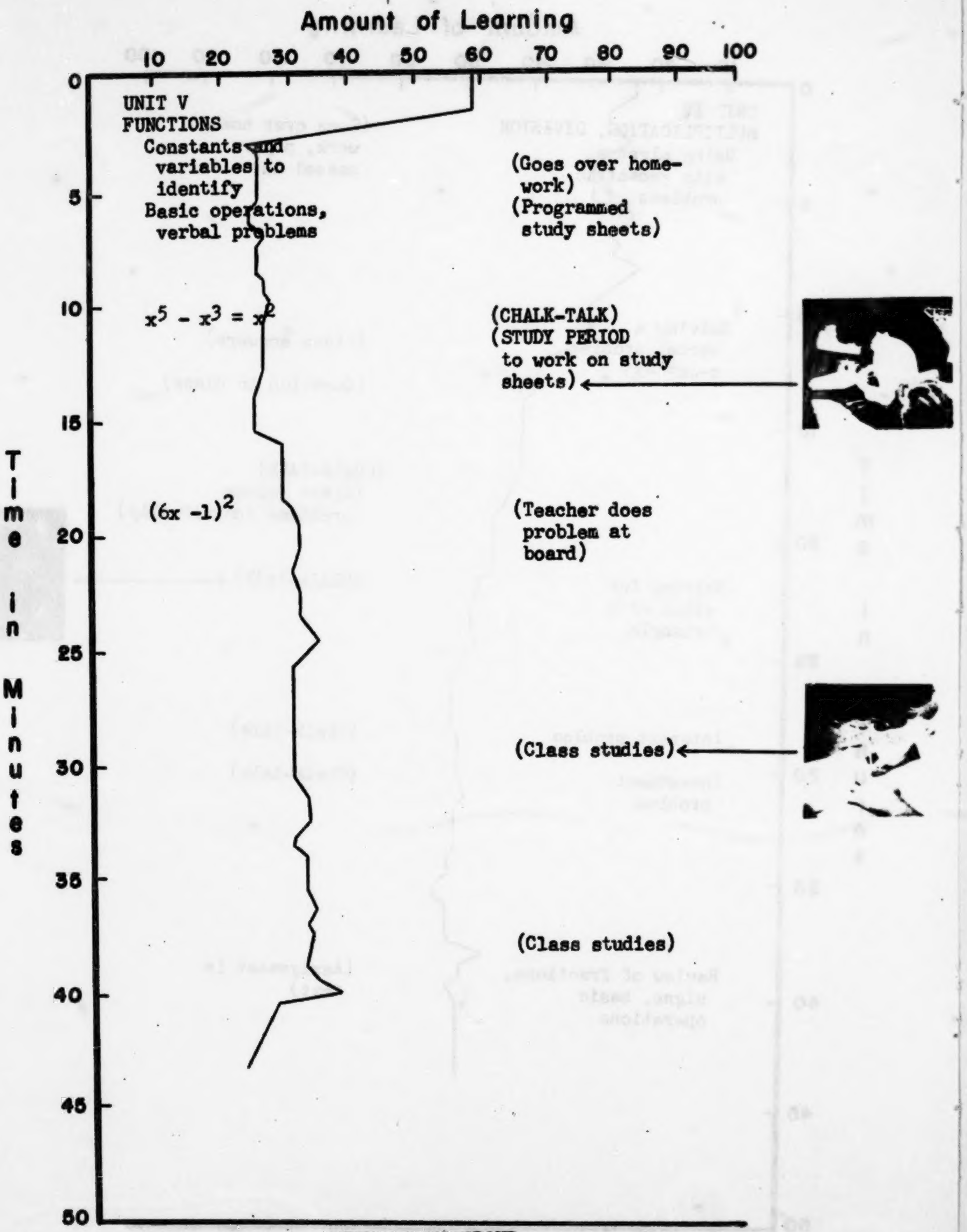
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 100



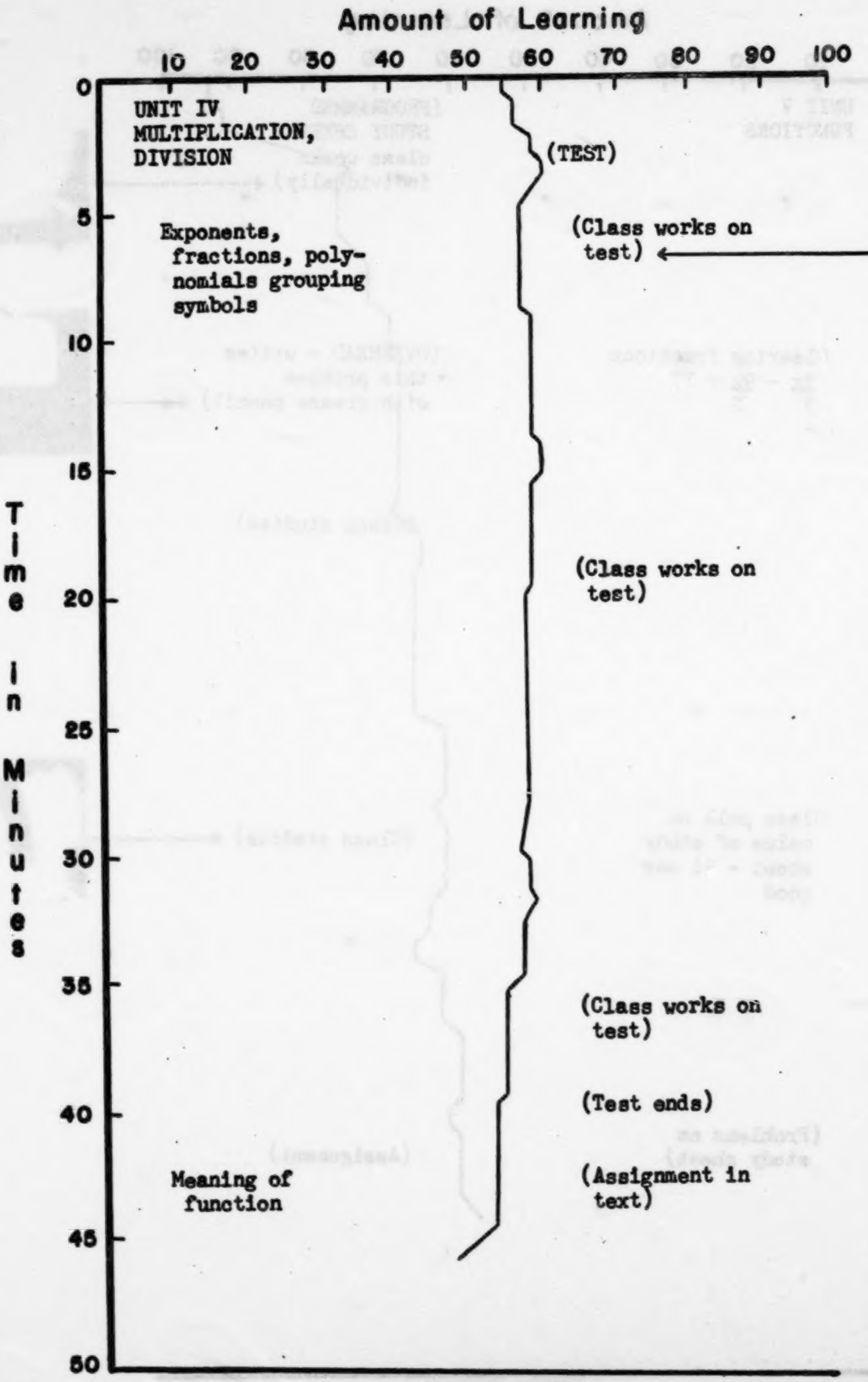
CONTROL GROUP

LEARNING PROFILE NUMBER 101



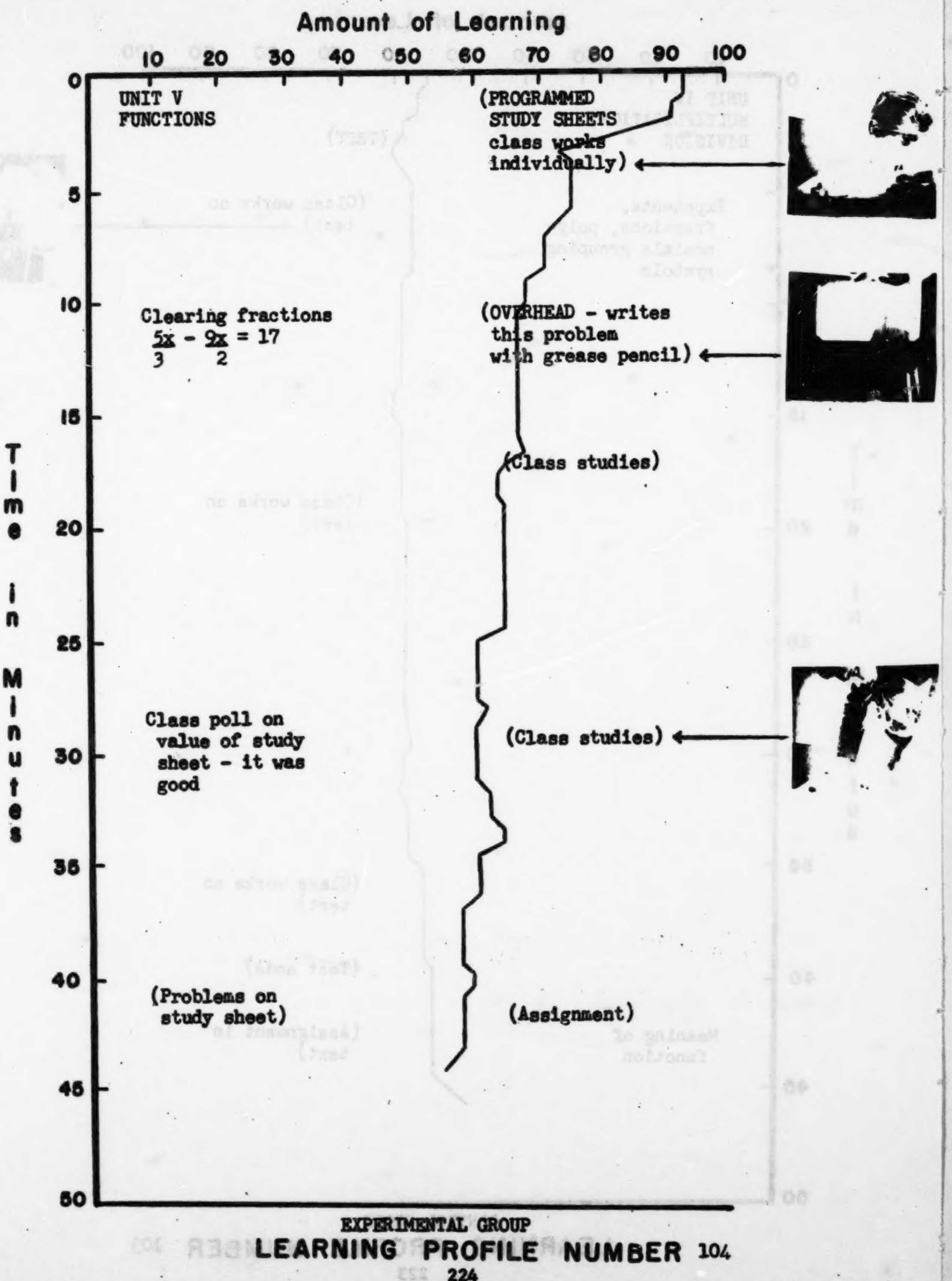
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 102



CONTROL GROUP

LEARNING PROFILE NUMBER 103



EXPERIMENTAL GROUP

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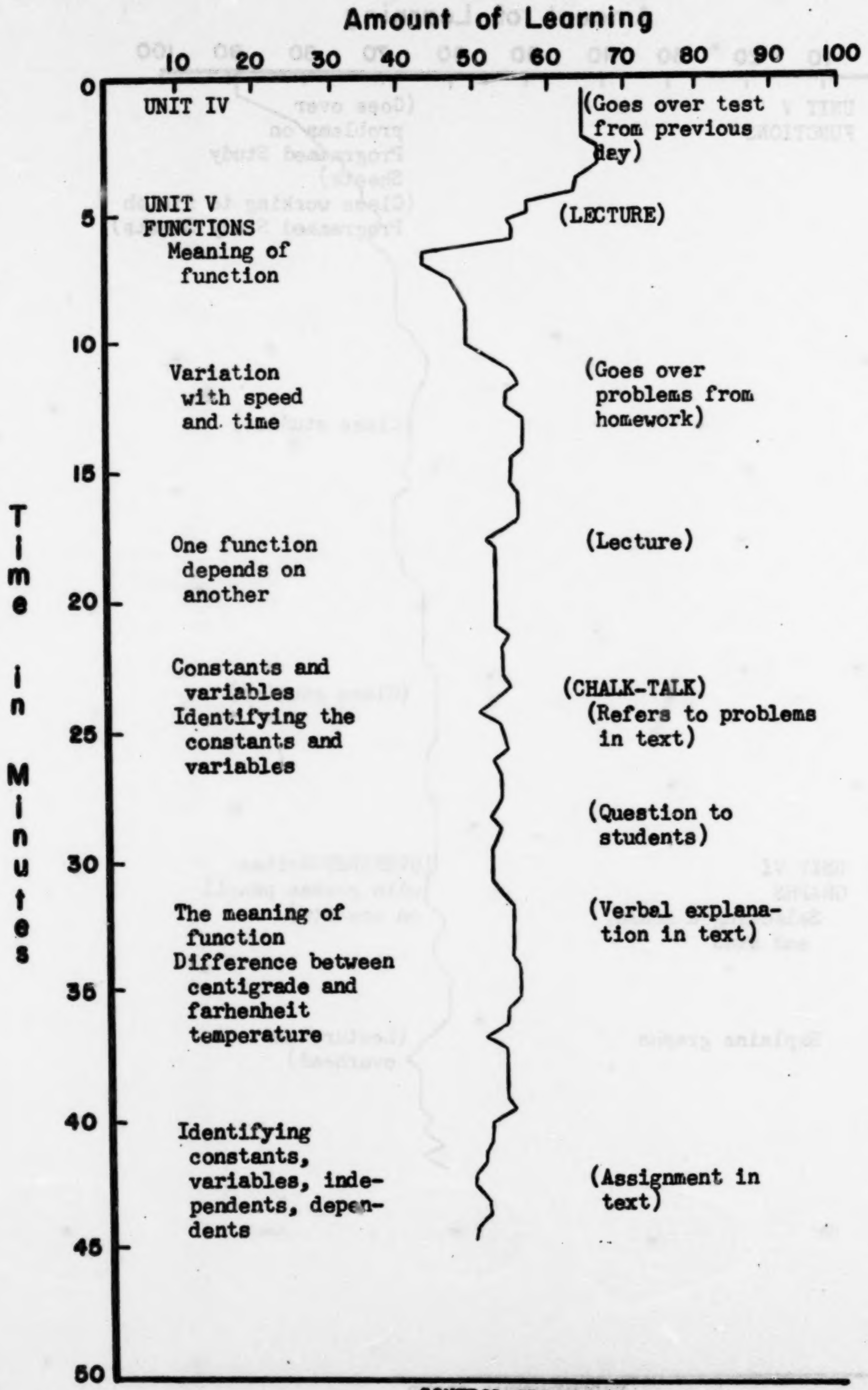
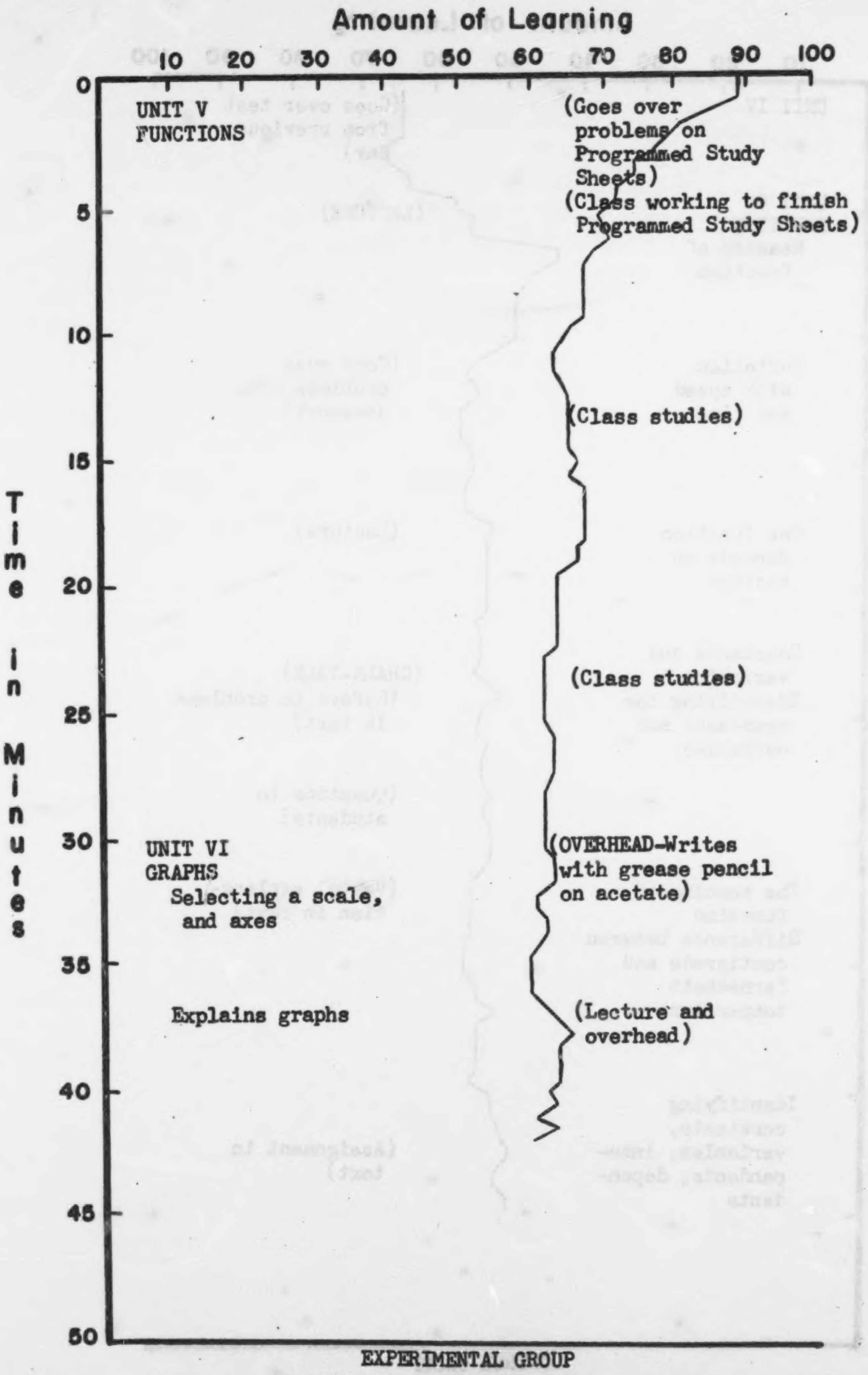


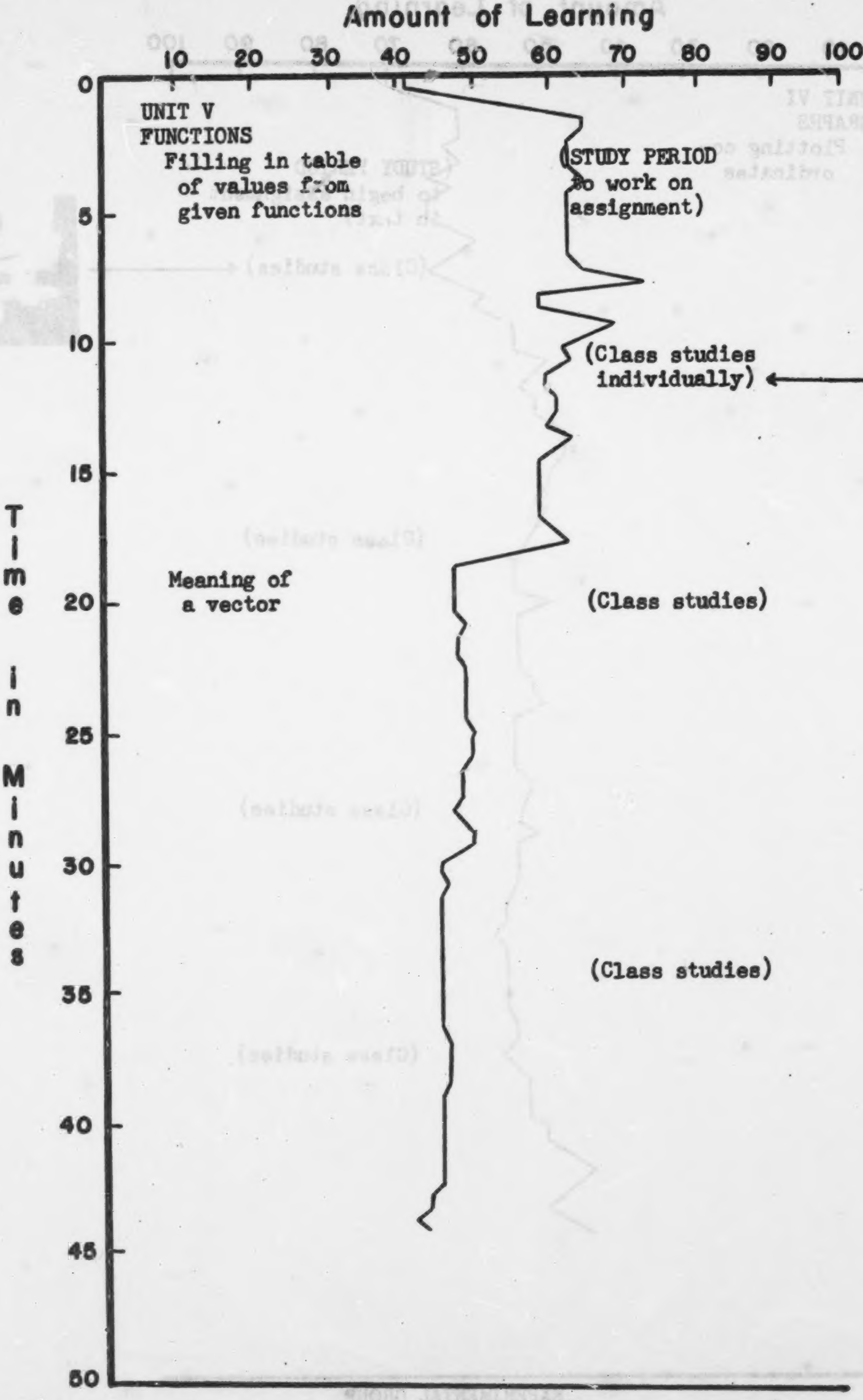
CONTROL GROUP

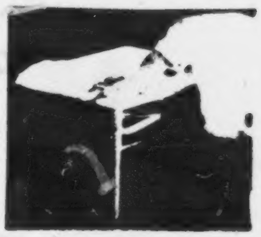
LEARNING PROFILE NUMBER 105



EXPERIMENTAL GROUP

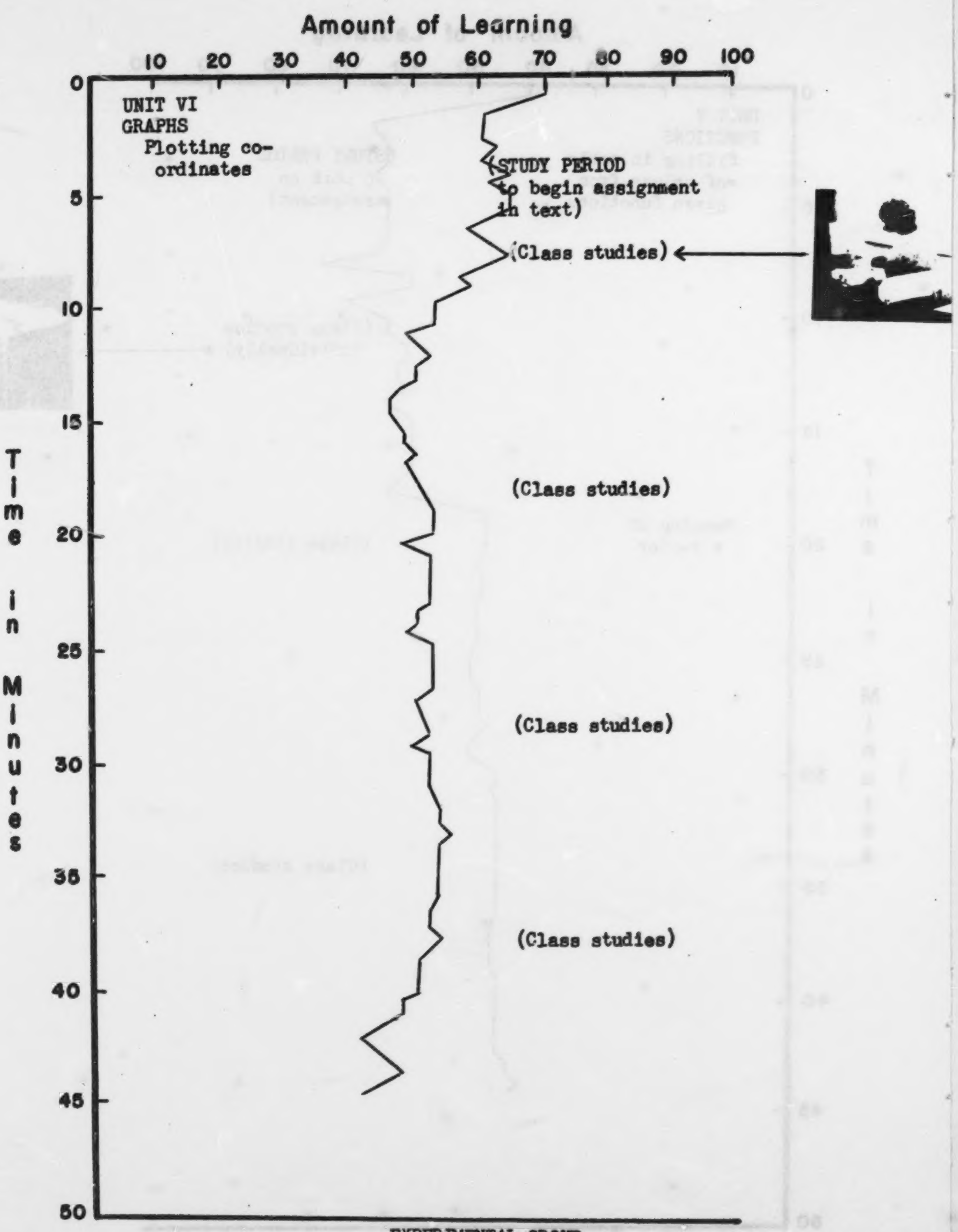
LEARNING PROFILE NUMBER 106





CONTROL GROUP

LEARNING PROFILE NUMBER 107



EXPERIMENTAL GROUP

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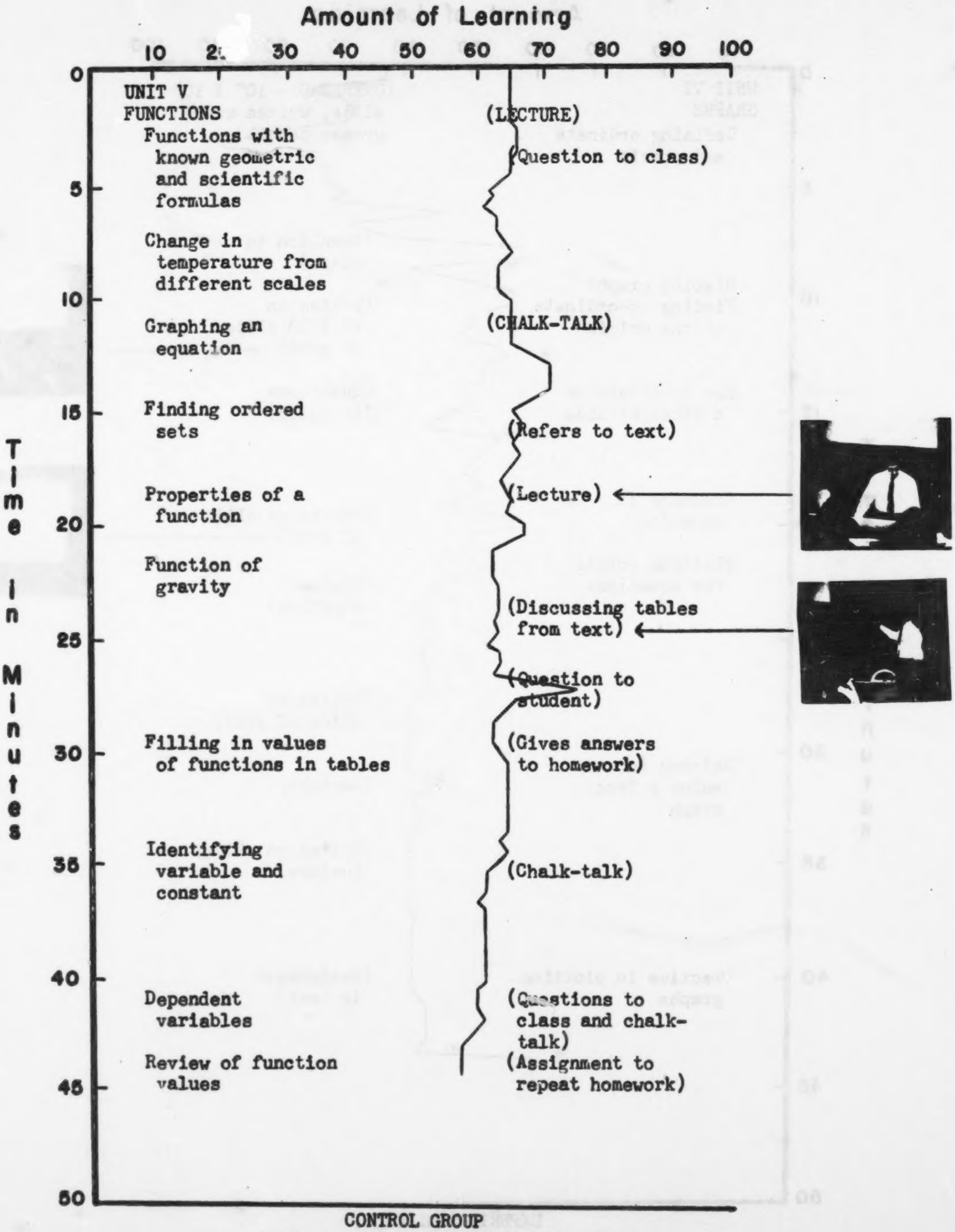
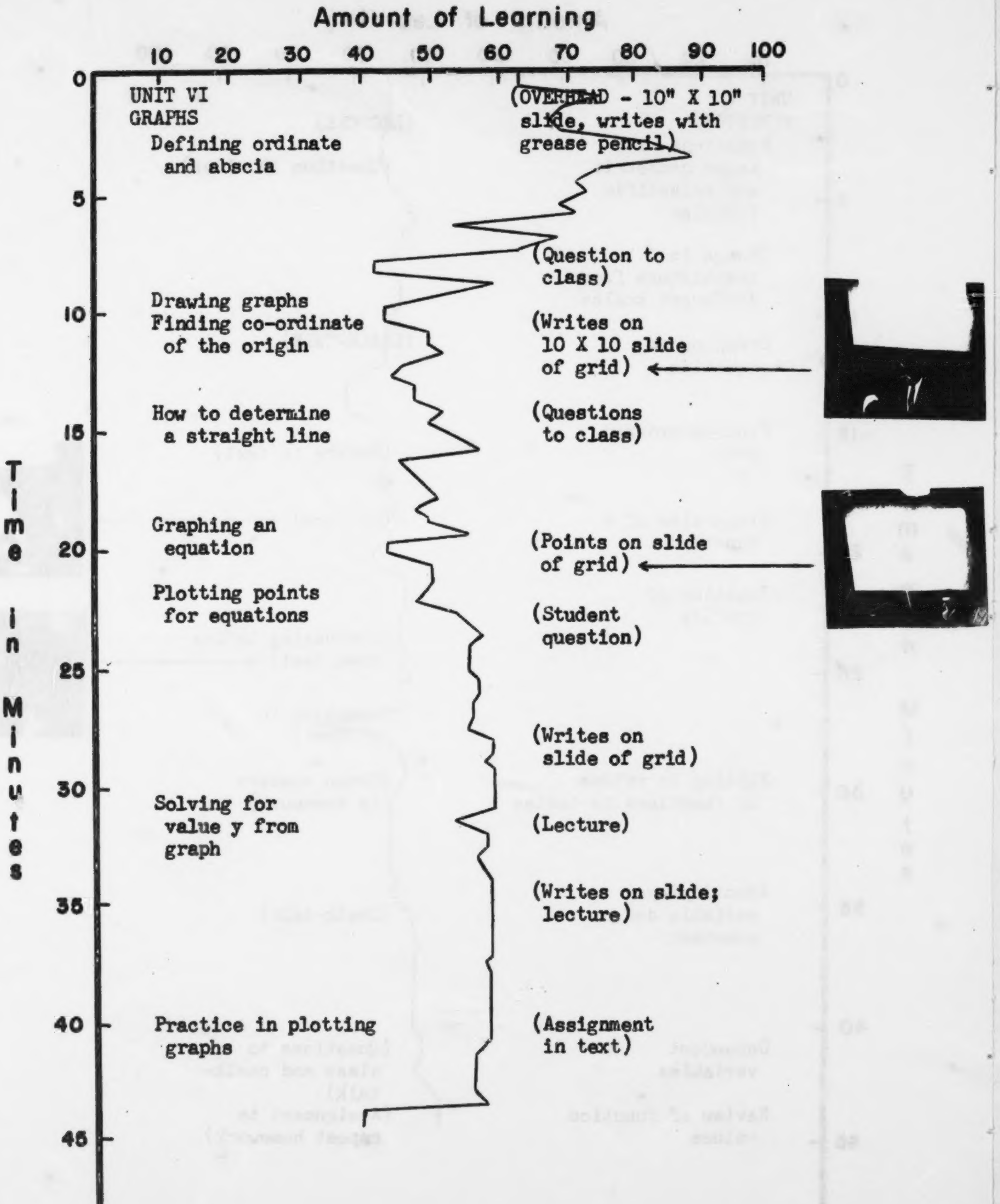


CONTROL GROUP

LEARNING PROFILE NUMBER 109



EXPERIMENTAL GROUP

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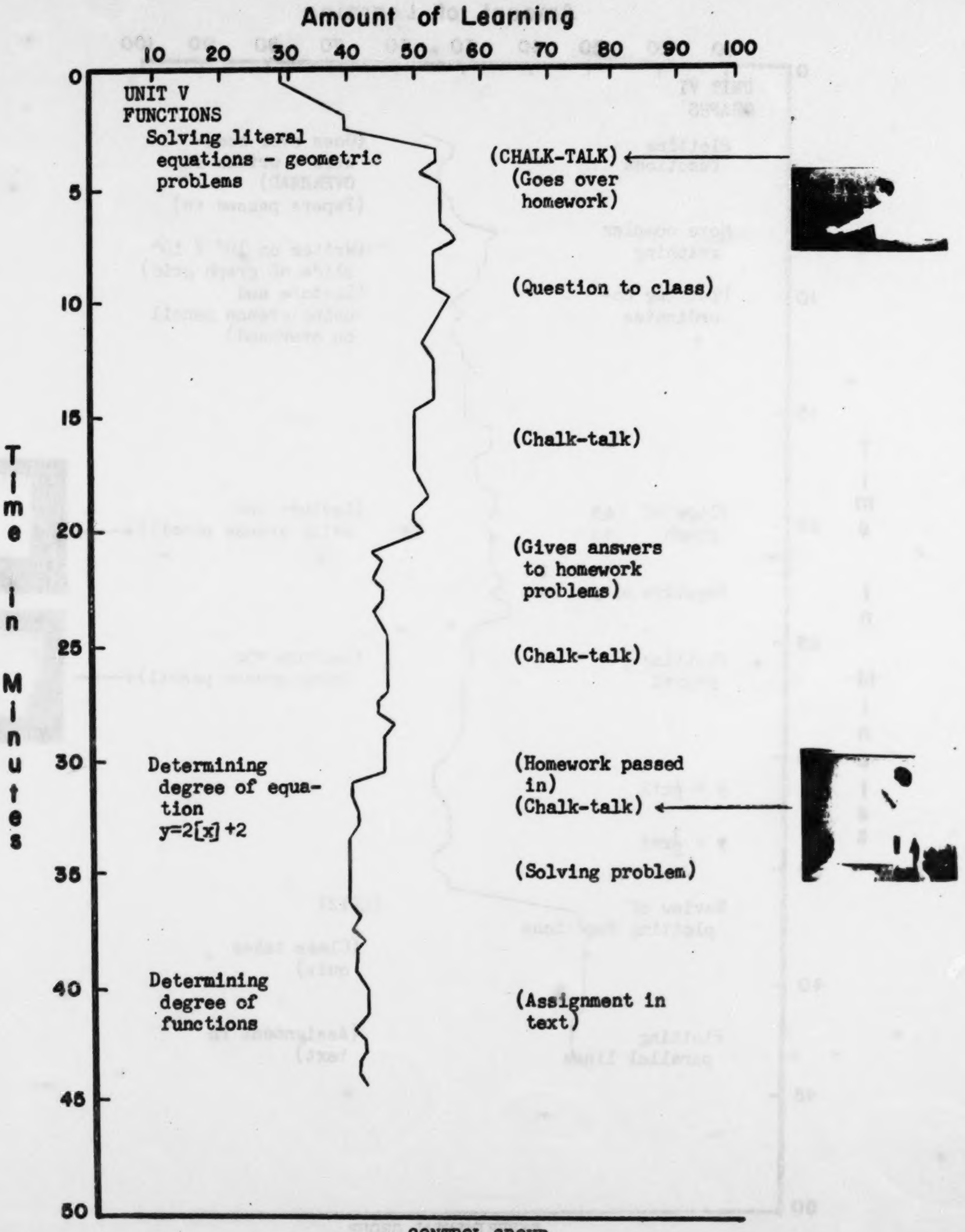
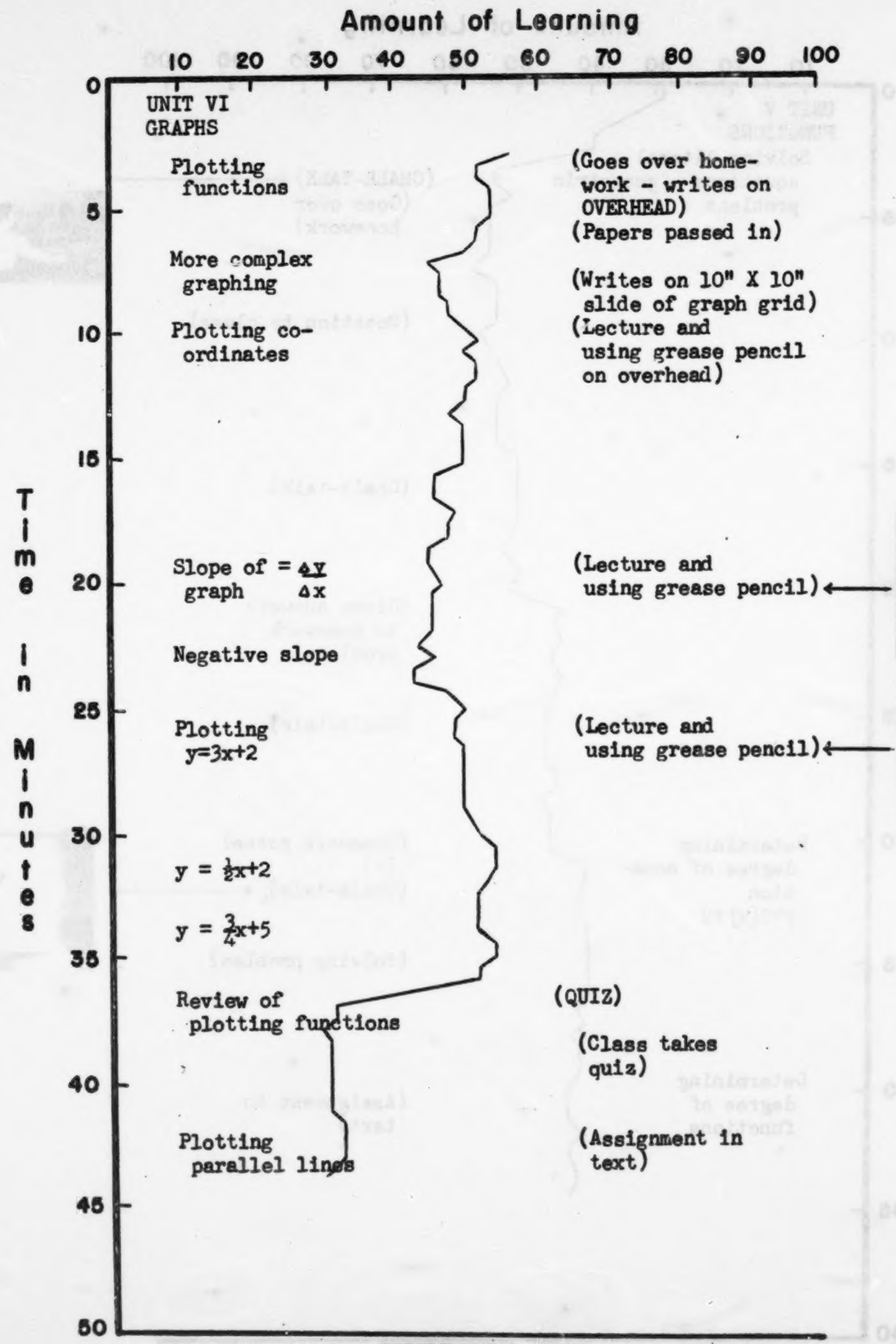


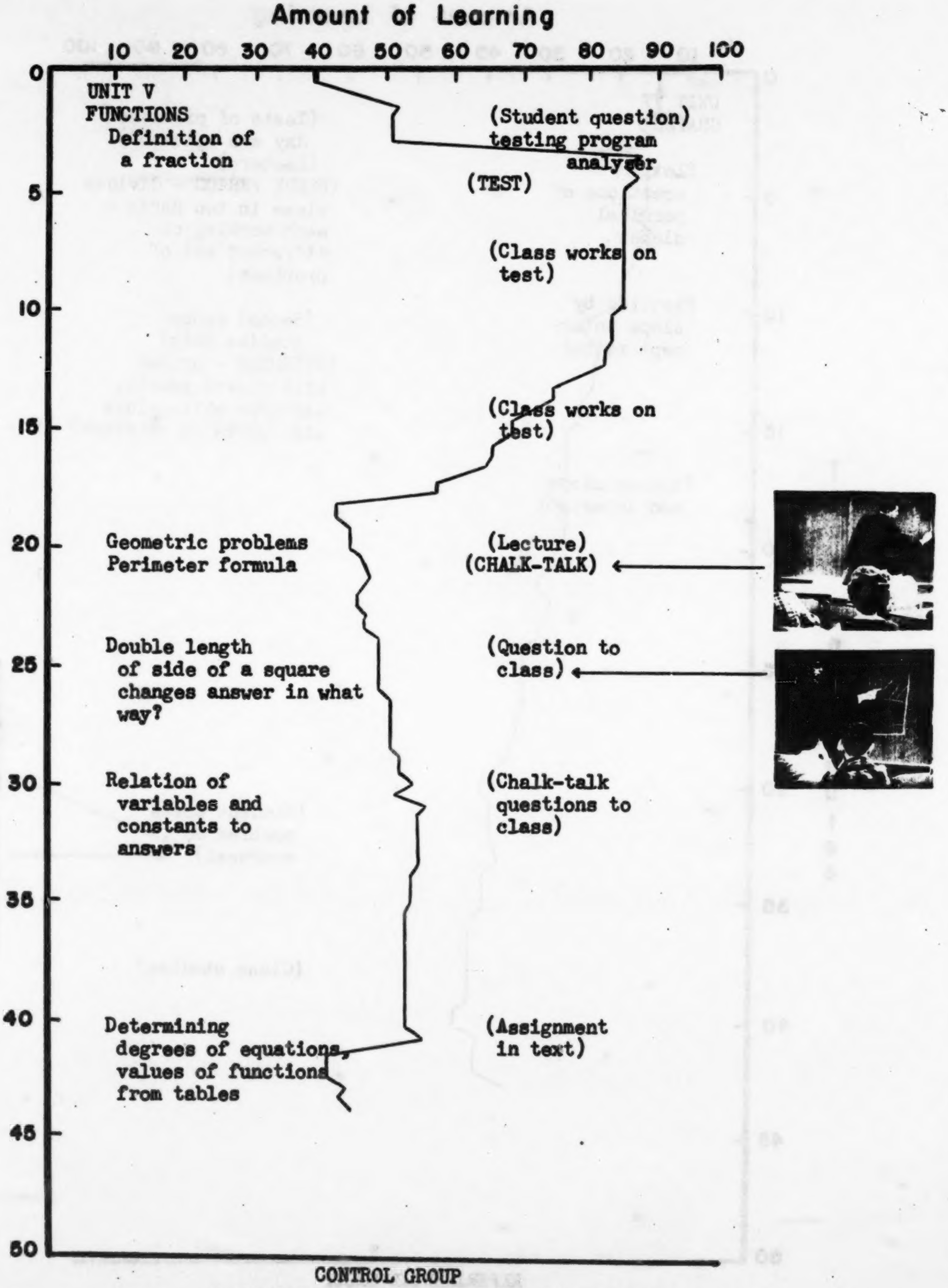
CONTROL GROUP

LEARNING PROFILE NUMBER 111



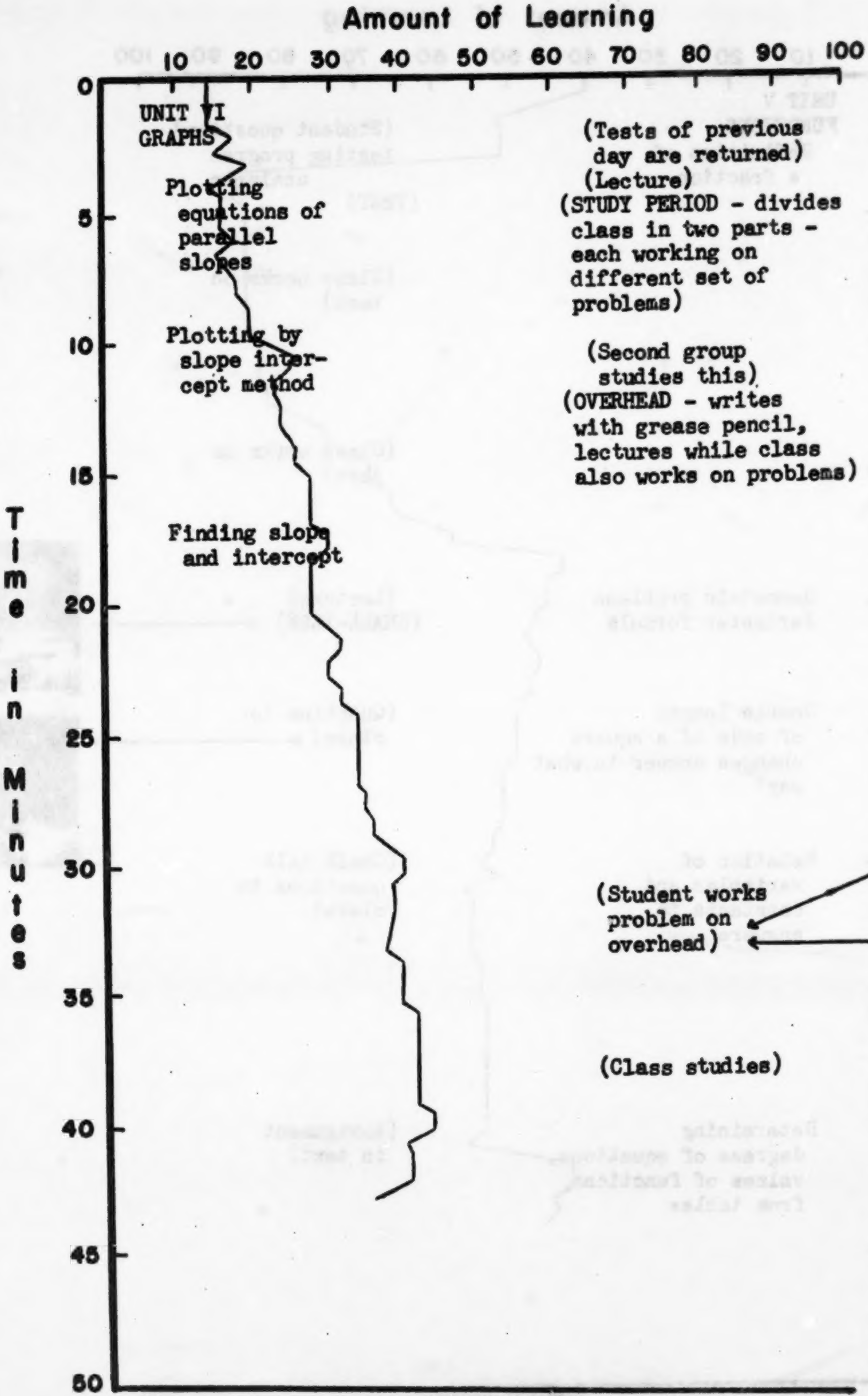
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 112



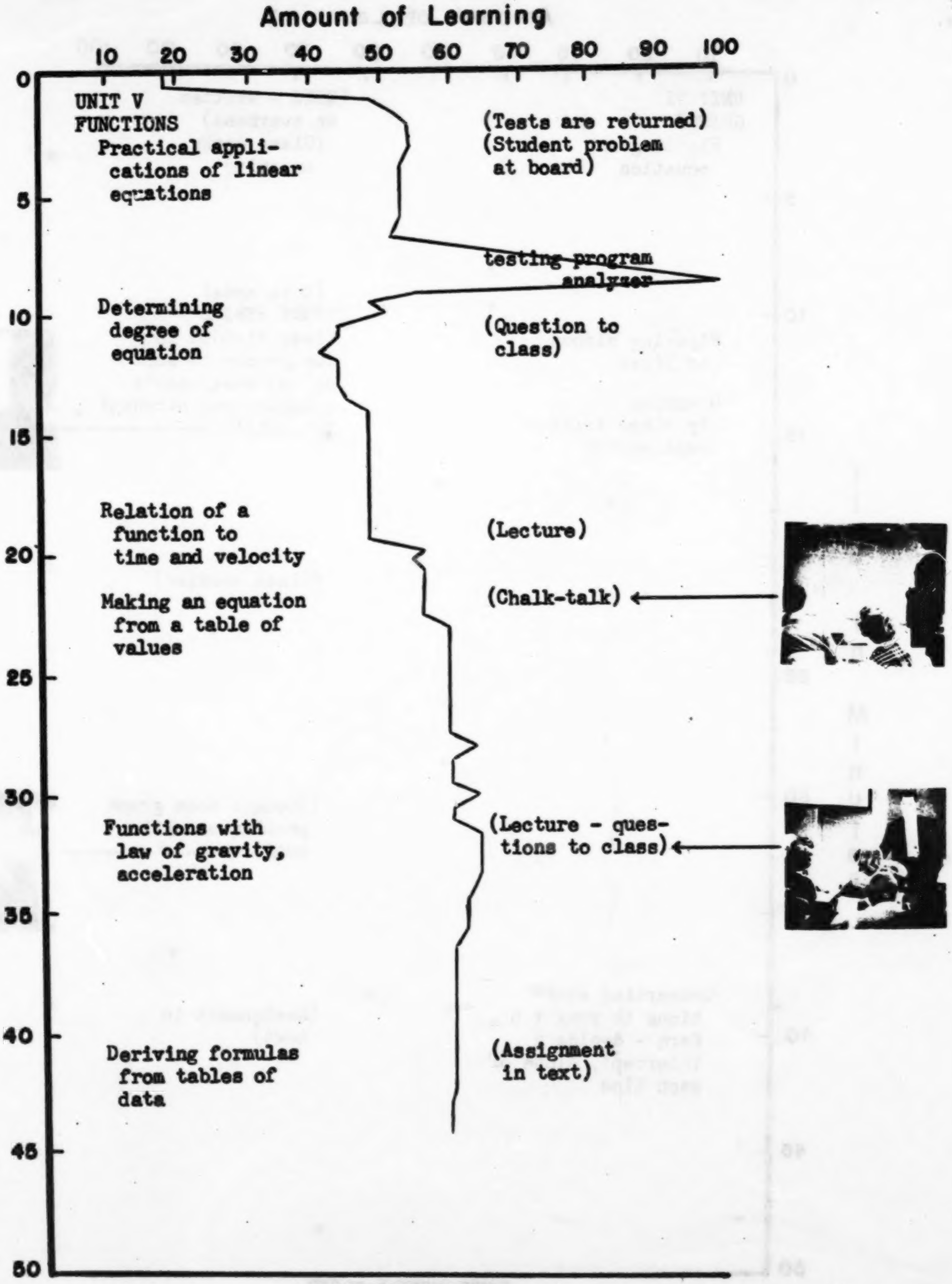
CONTROL GROUP

LEARNING PROFILE NUMBER 113



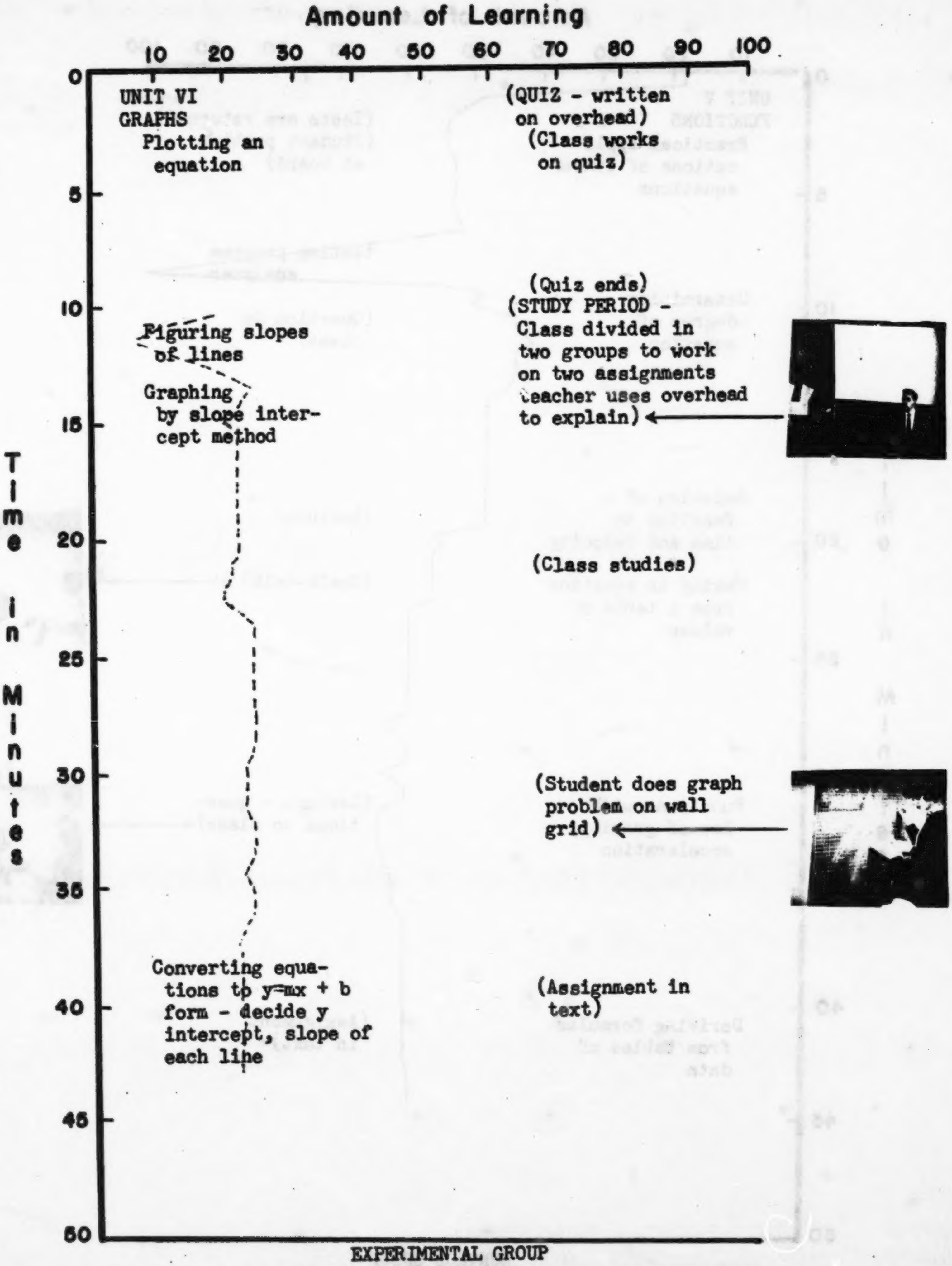
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 114



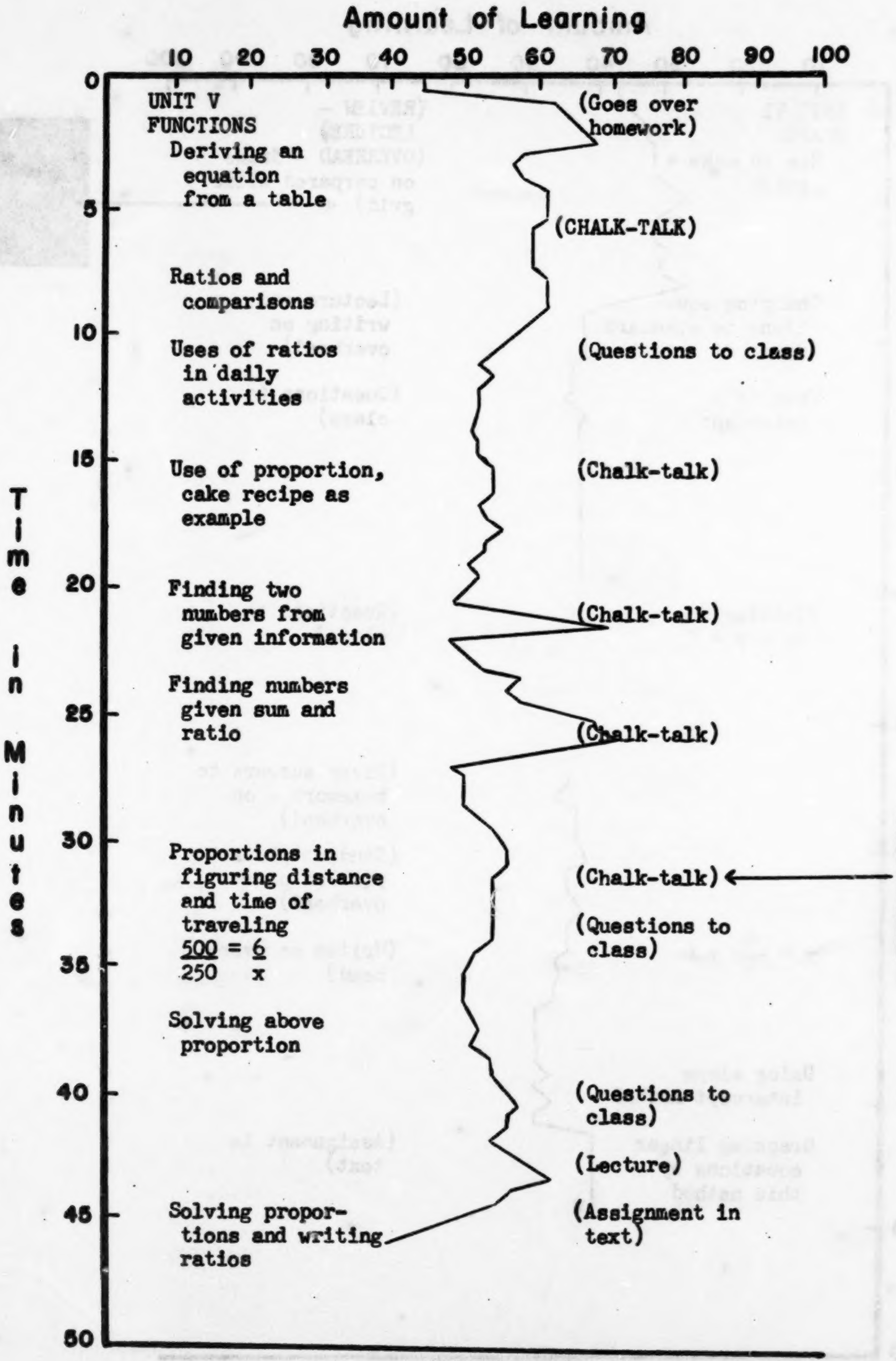
CONTROL GROUP

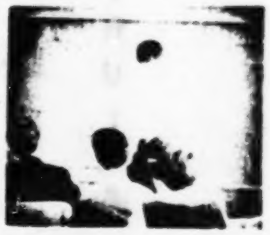
LEARNING PROFILE NUMBER 115



EXPERIMENTAL GROUP

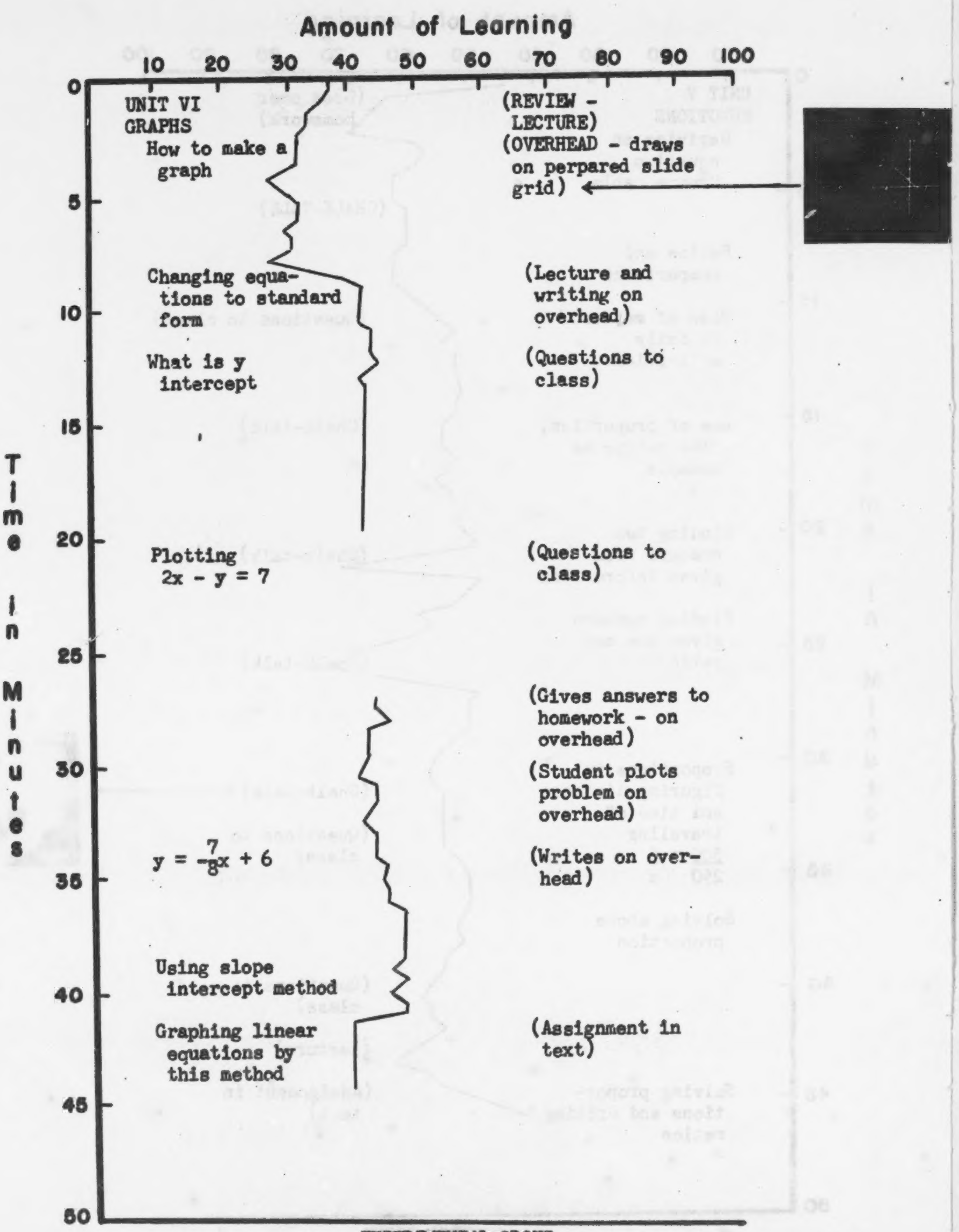
LEARNING PROFILE NUMBER 116





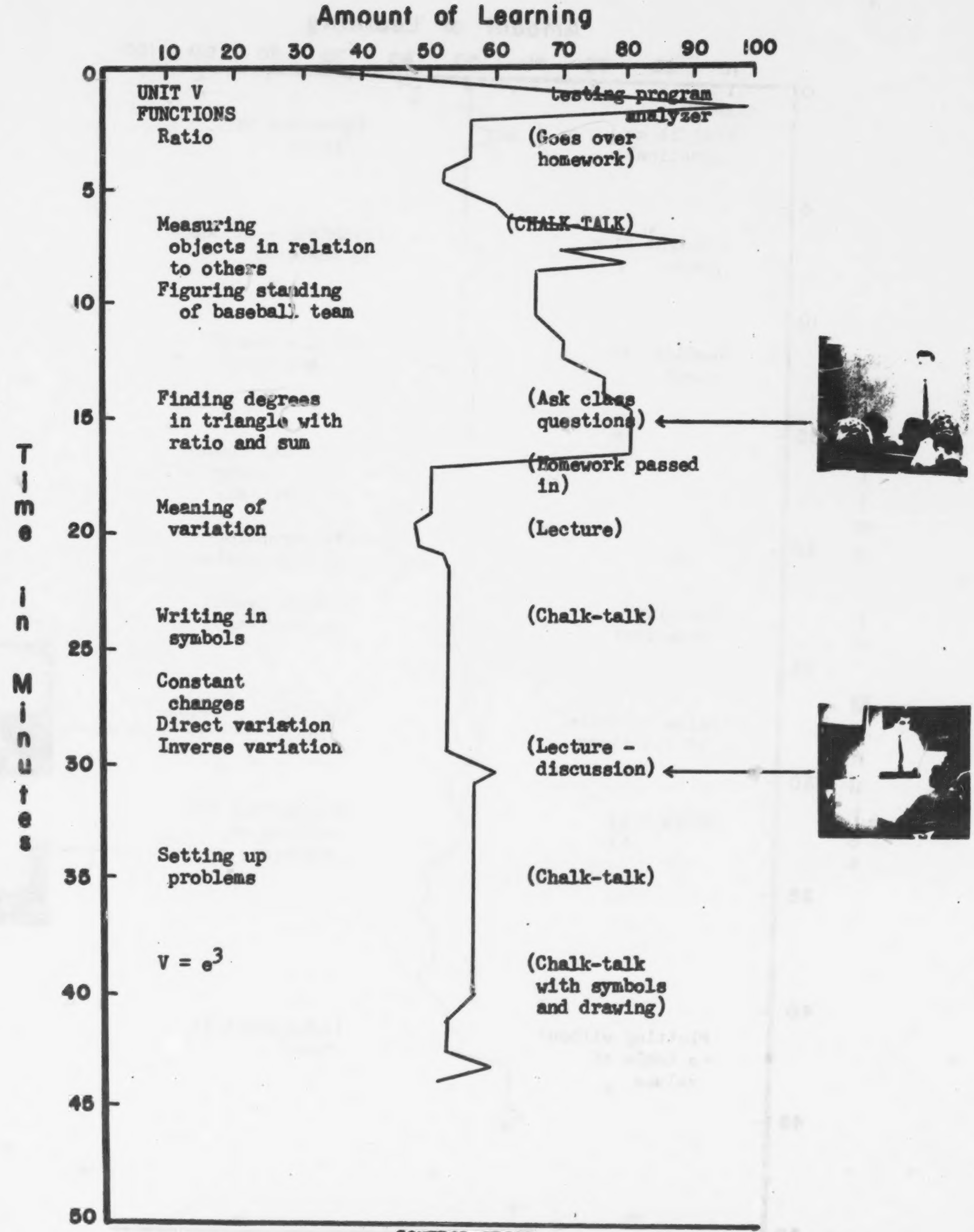
CONTROL GROUP

LEARNING PROFILE NUMBER 117



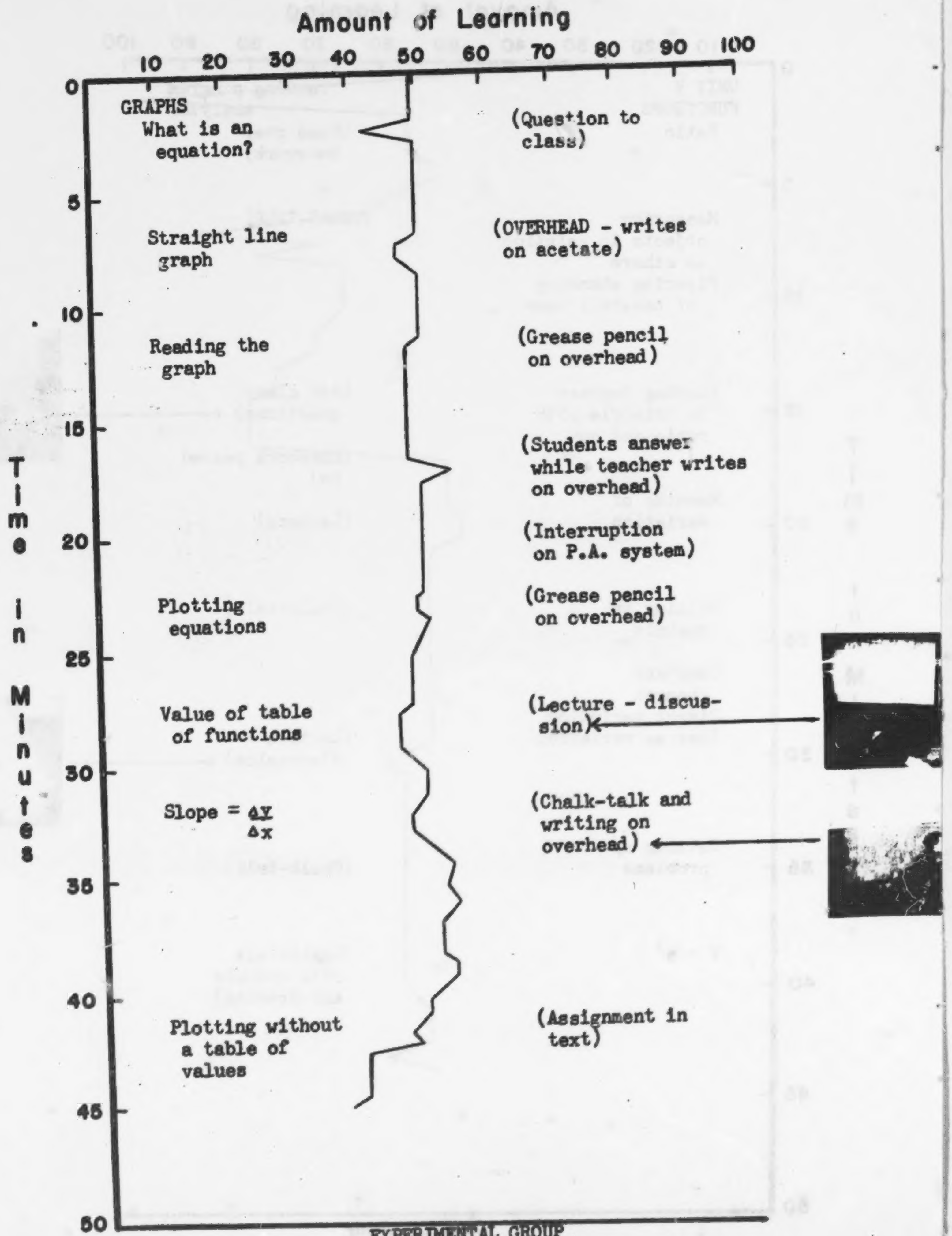
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 118



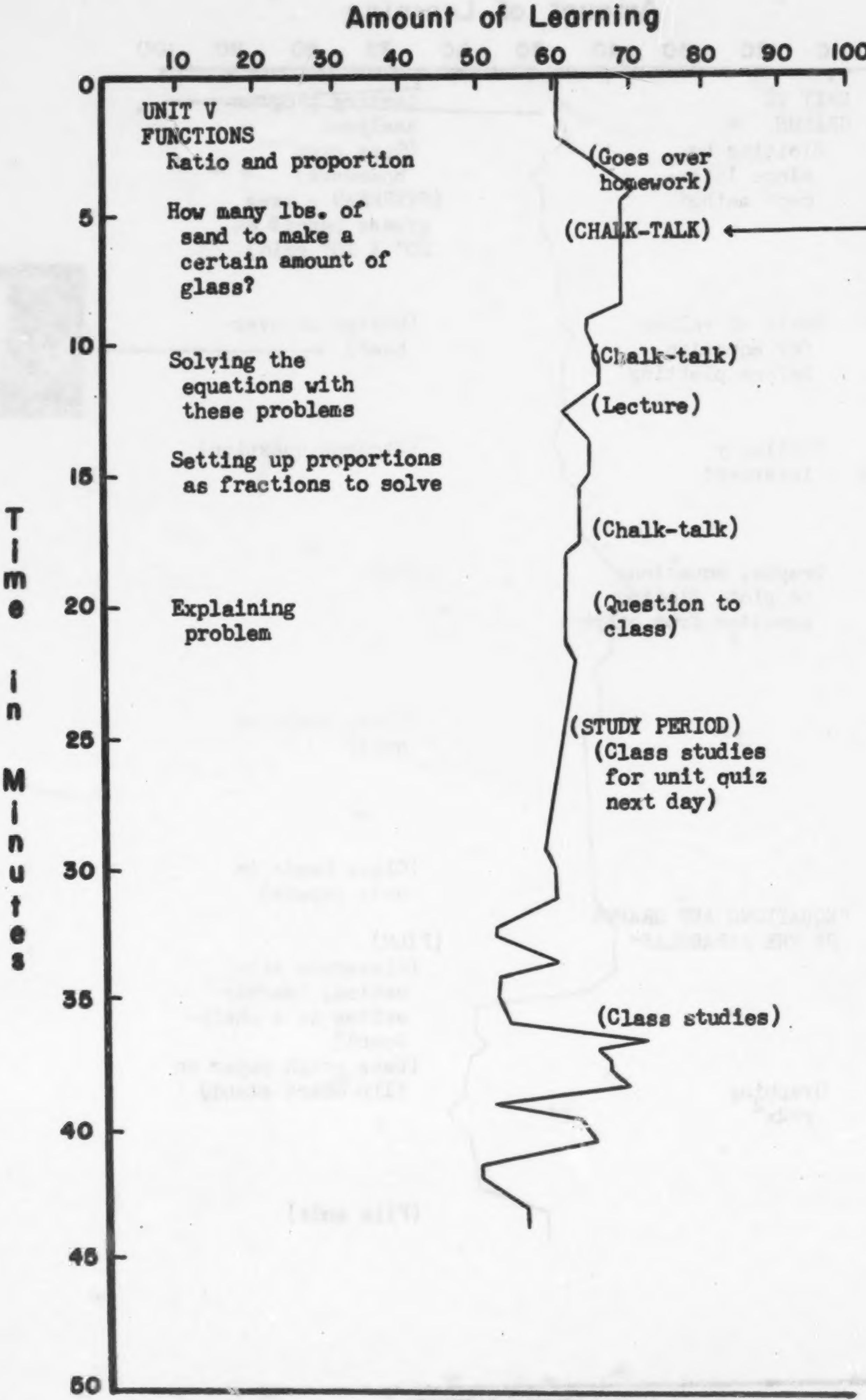
CONTROL GROUP

LEARNING PROFILE NUMBER 119



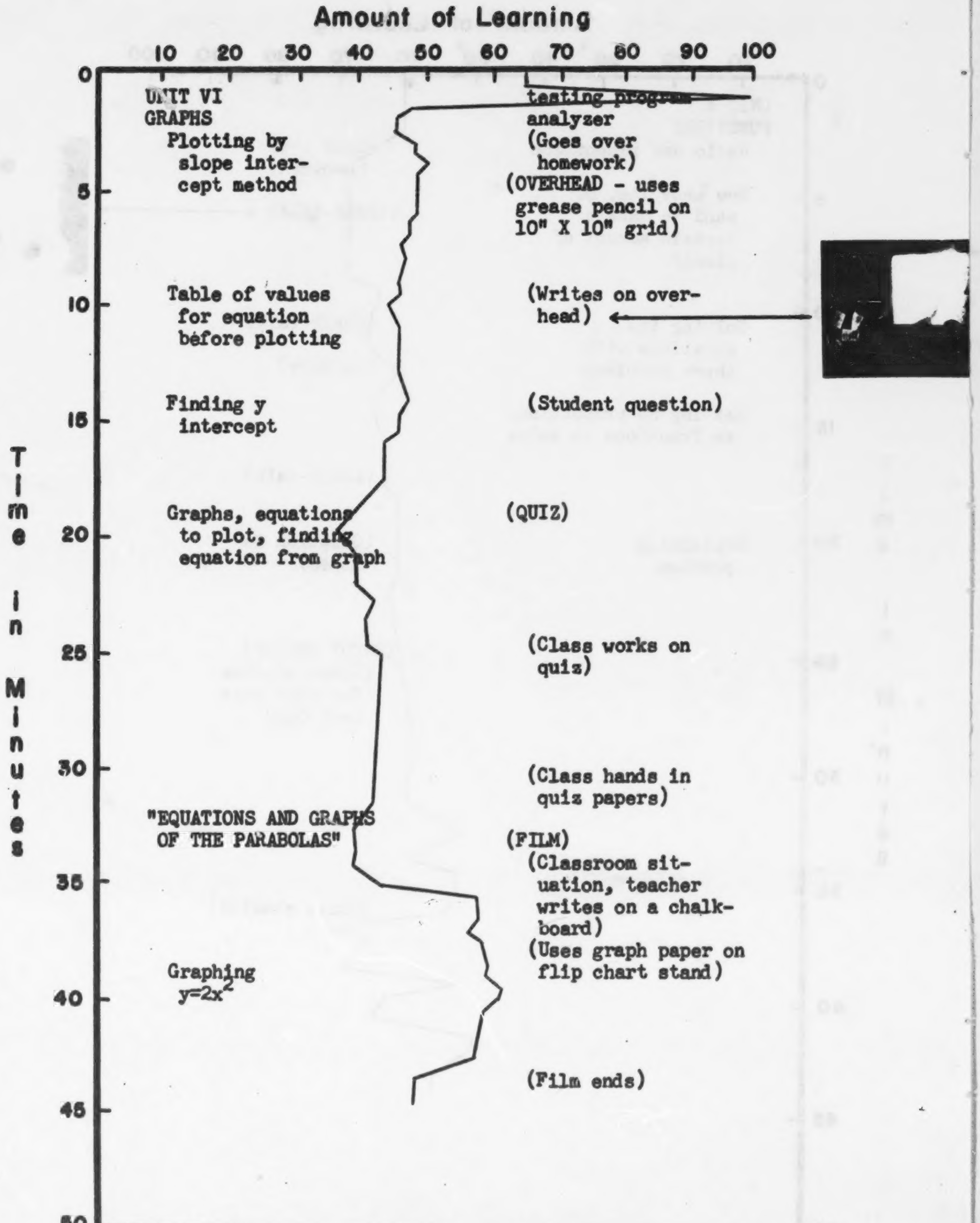
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 120



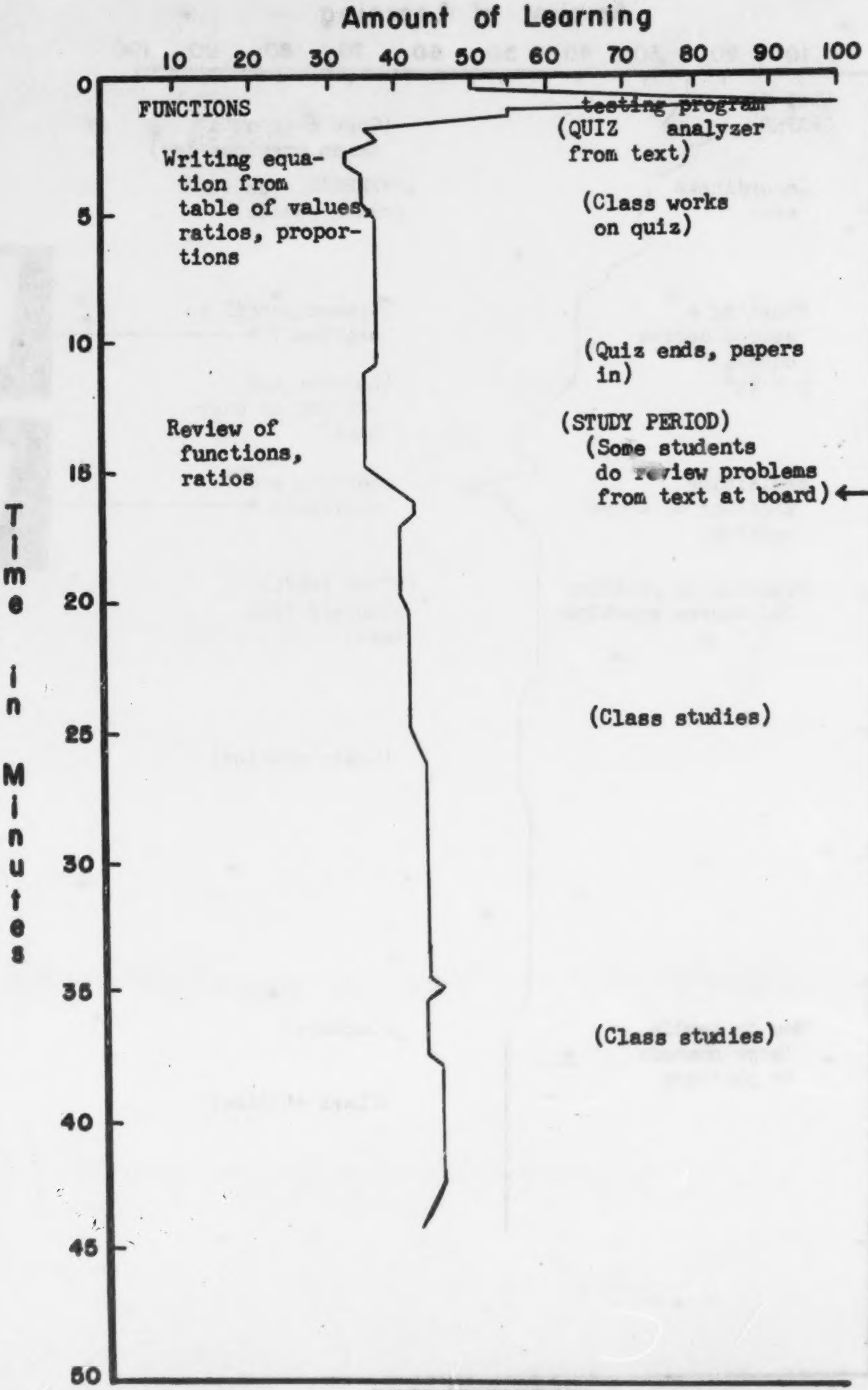
CONTROL GROUP

LEARNING PROFILE NUMBER 121



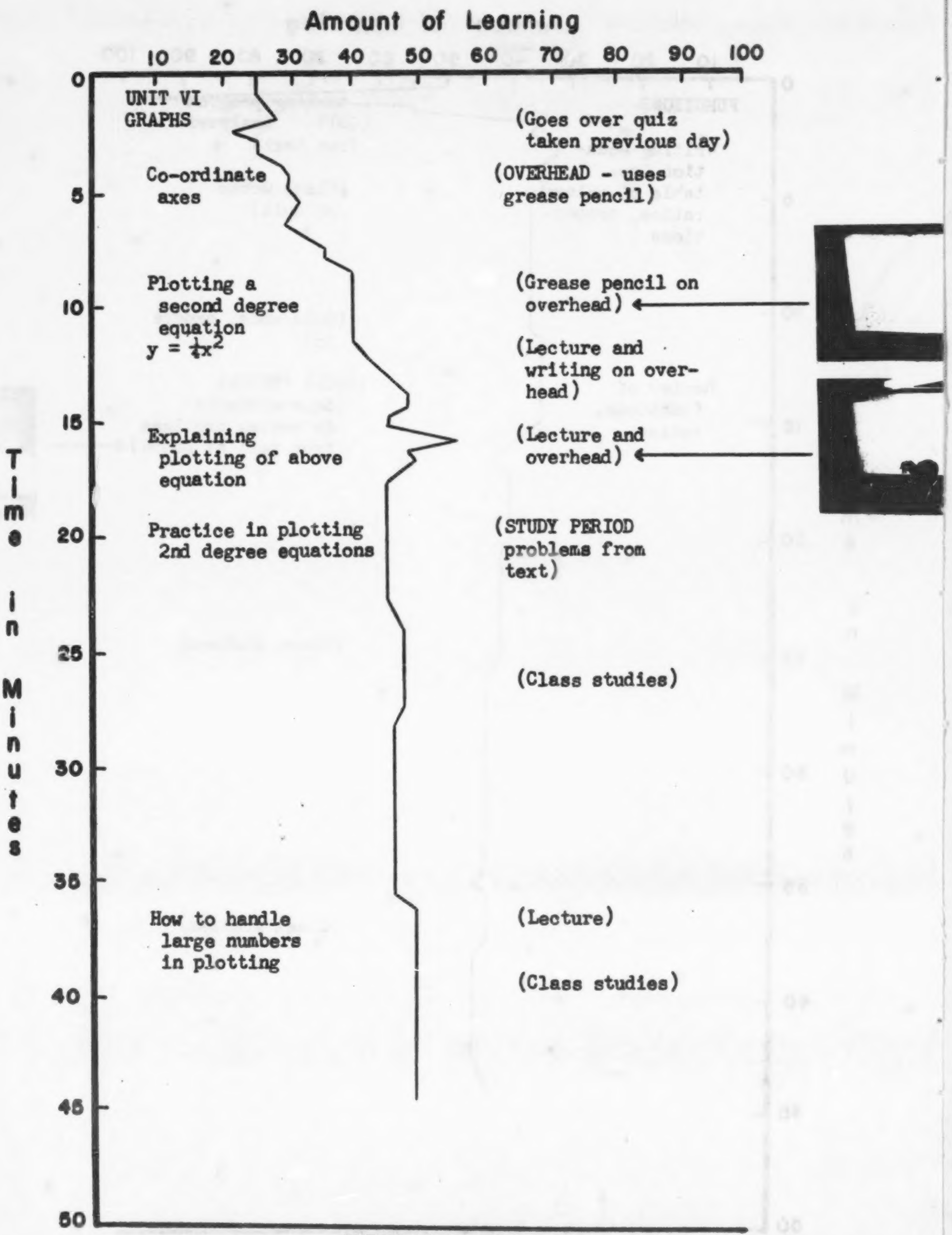
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 122



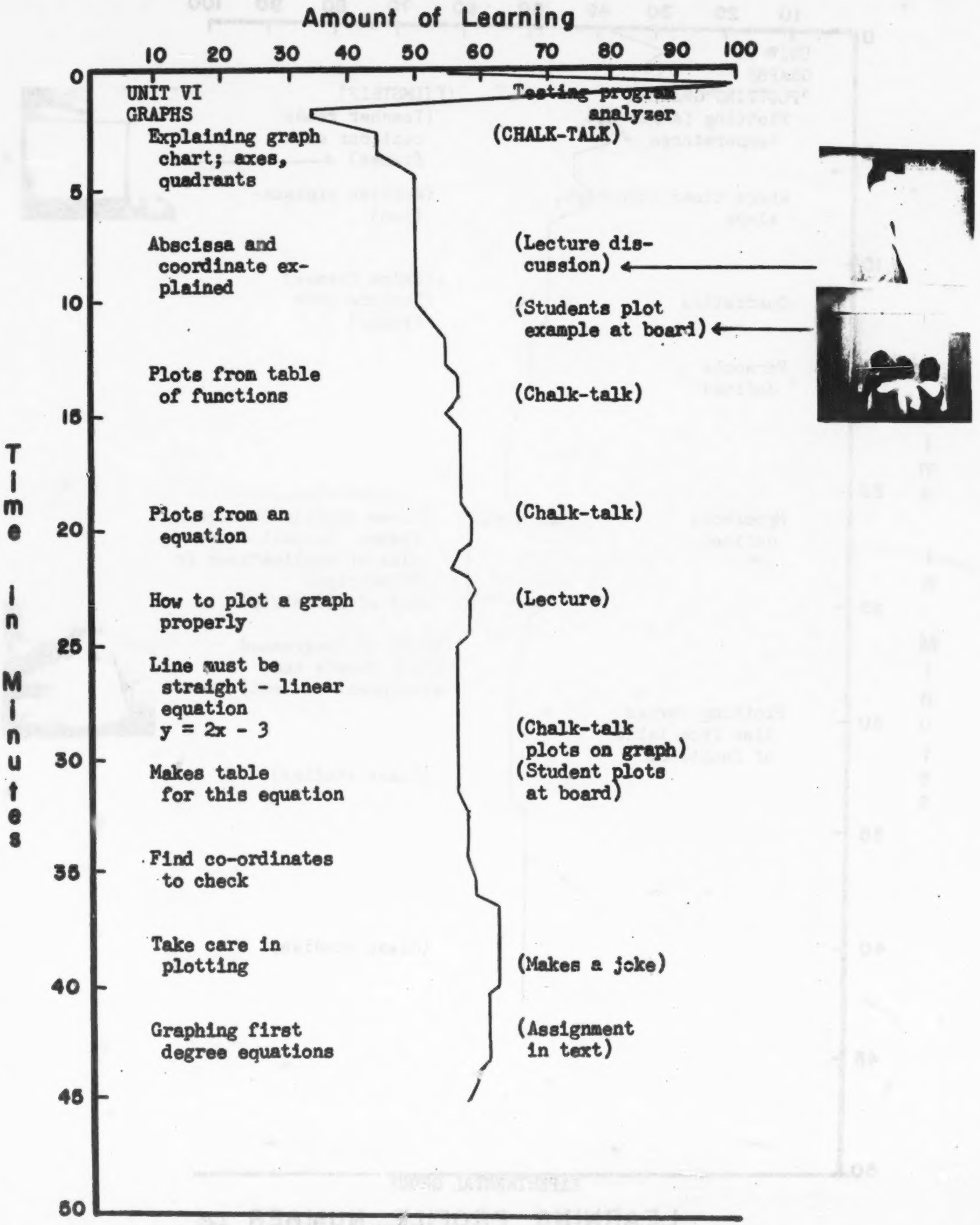
CONTROL GROUP

LEARNING PROFILE NUMBER 123



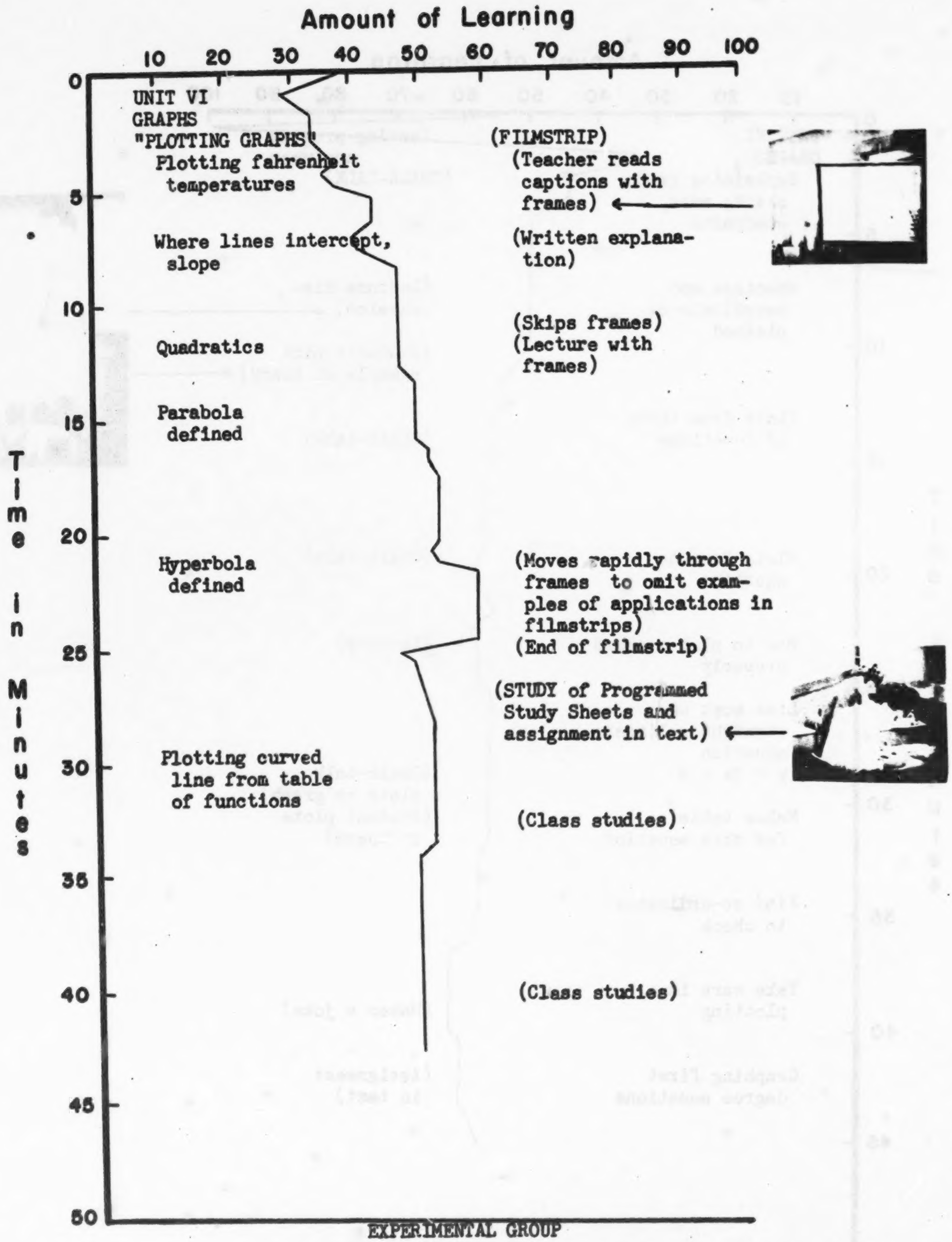
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 124



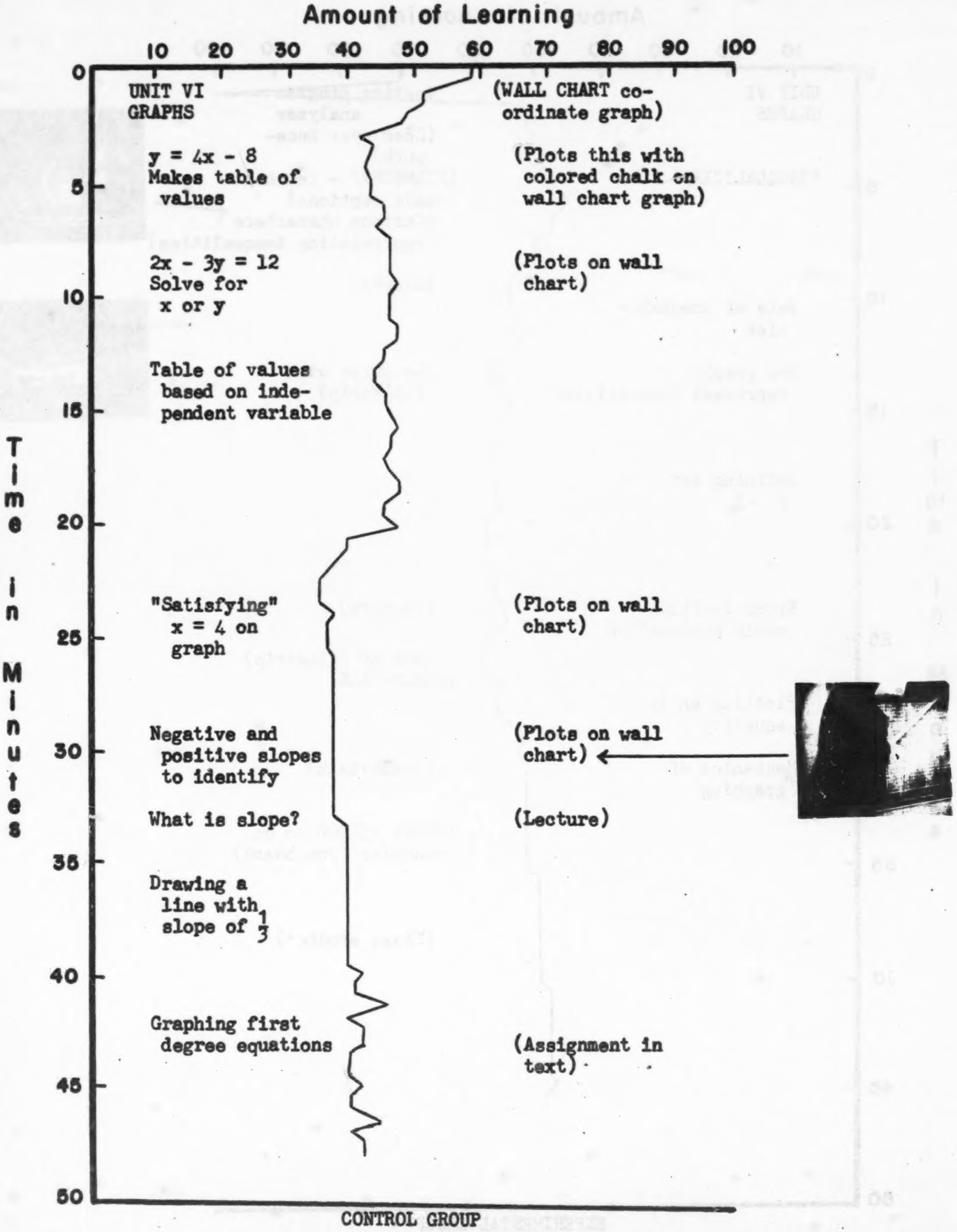
CONTROL GROUP

LEARNING PROFILE NUMBER 125



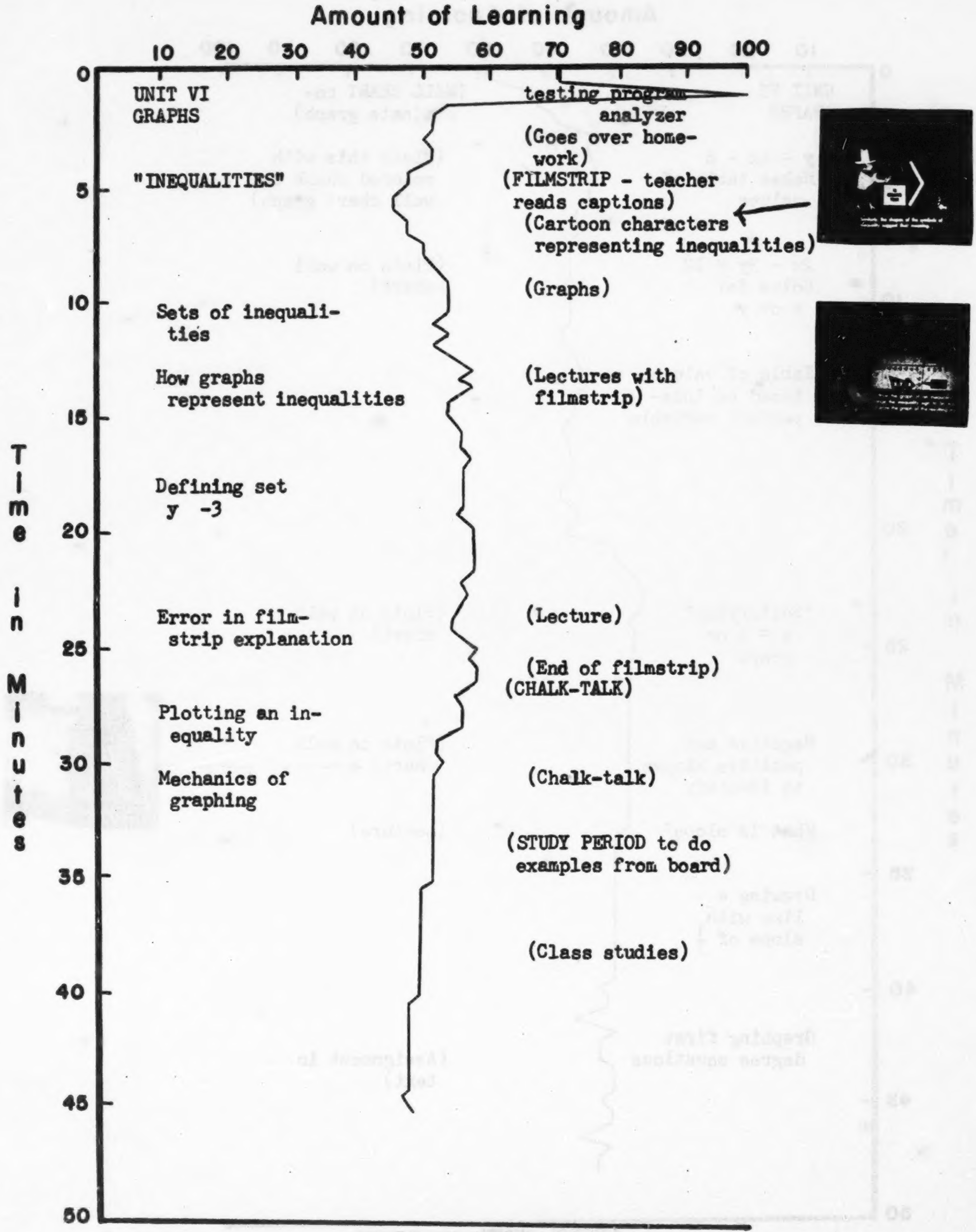
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 126



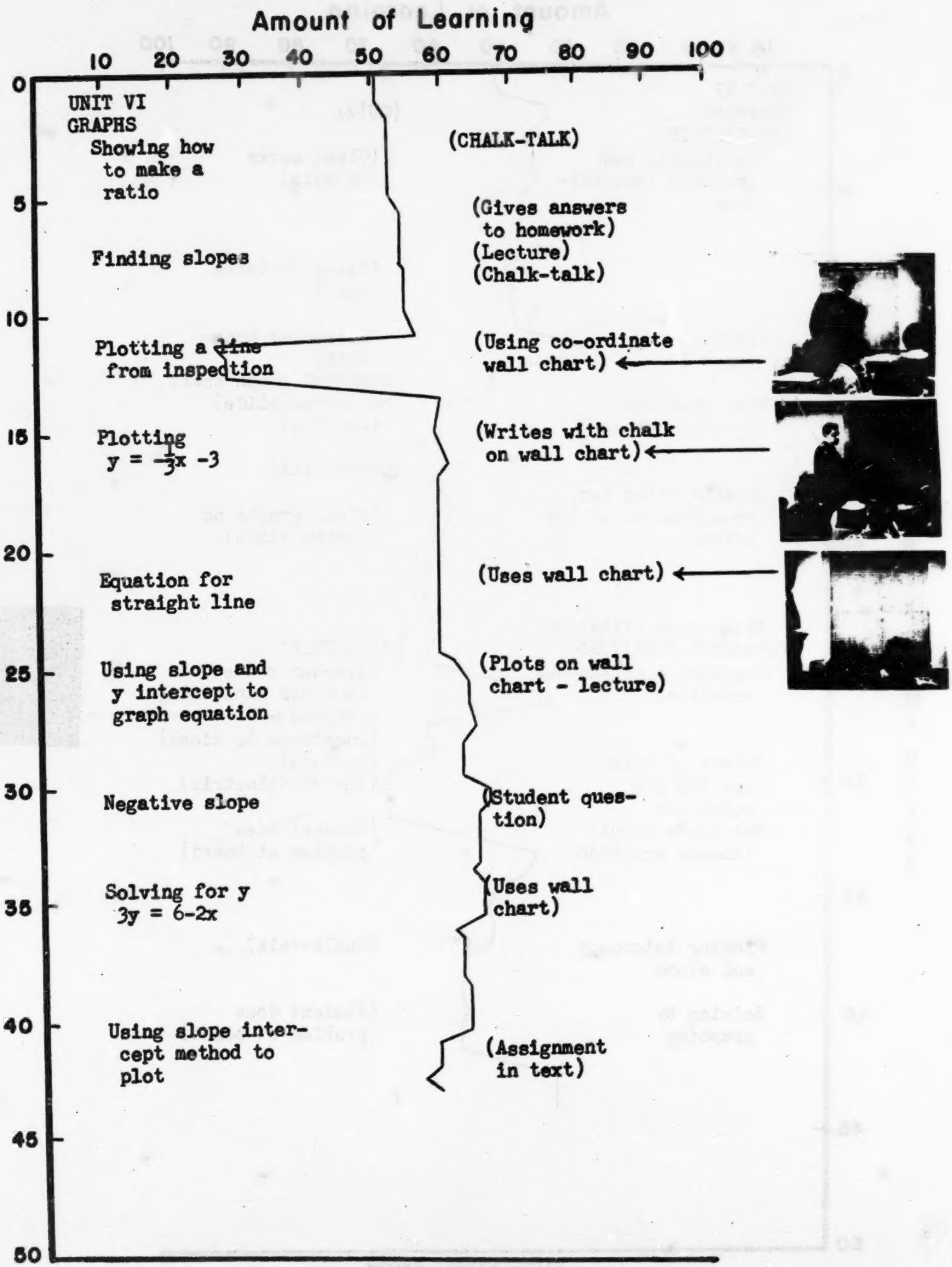
CONTROL GROUP

LEARNING PROFILE NUMBER 127



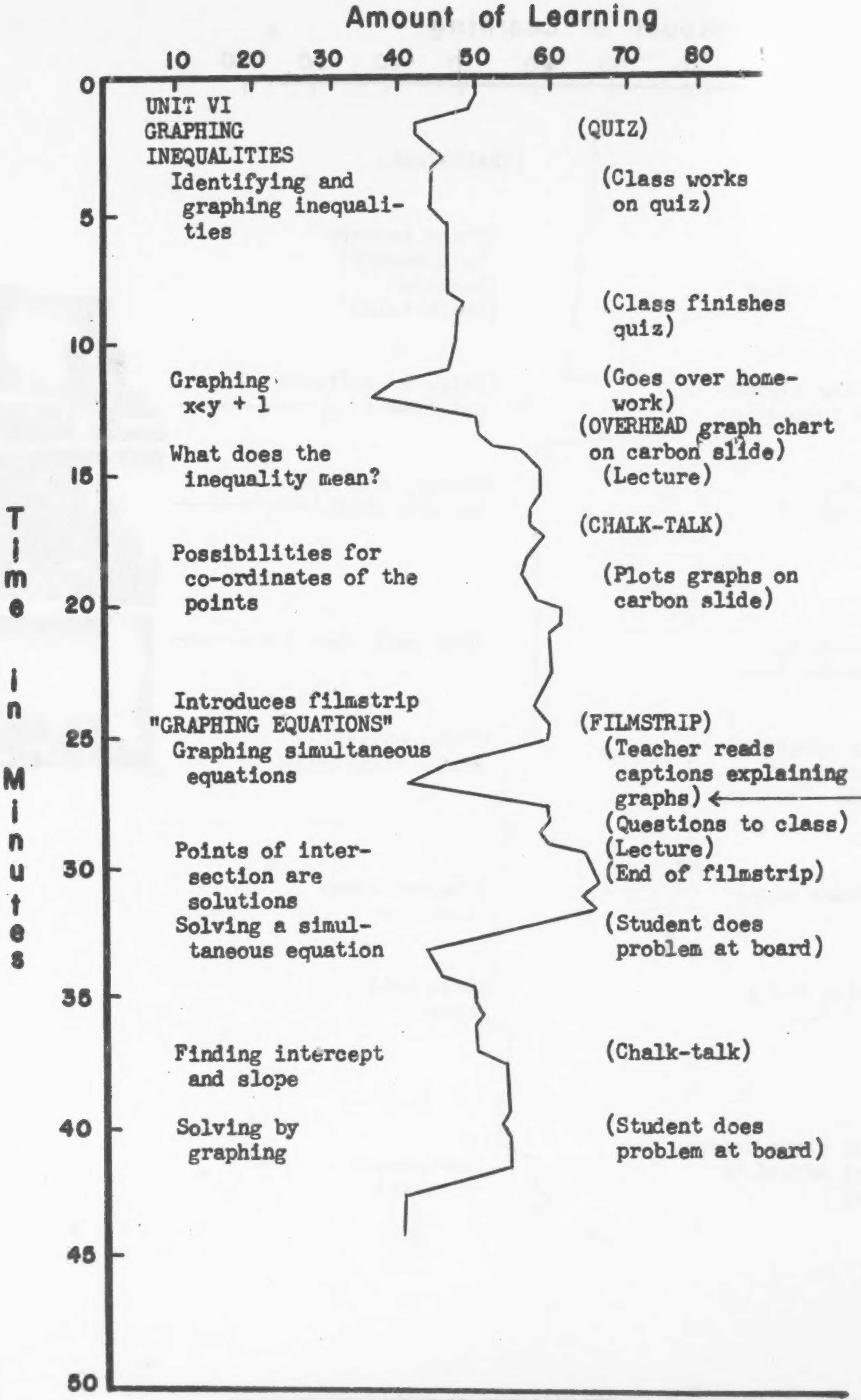
EXPERIMENTAL GROUP

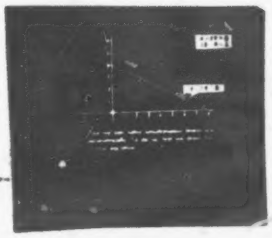
LEARNING PROFILE NUMBER 128



CONTROL GROUP

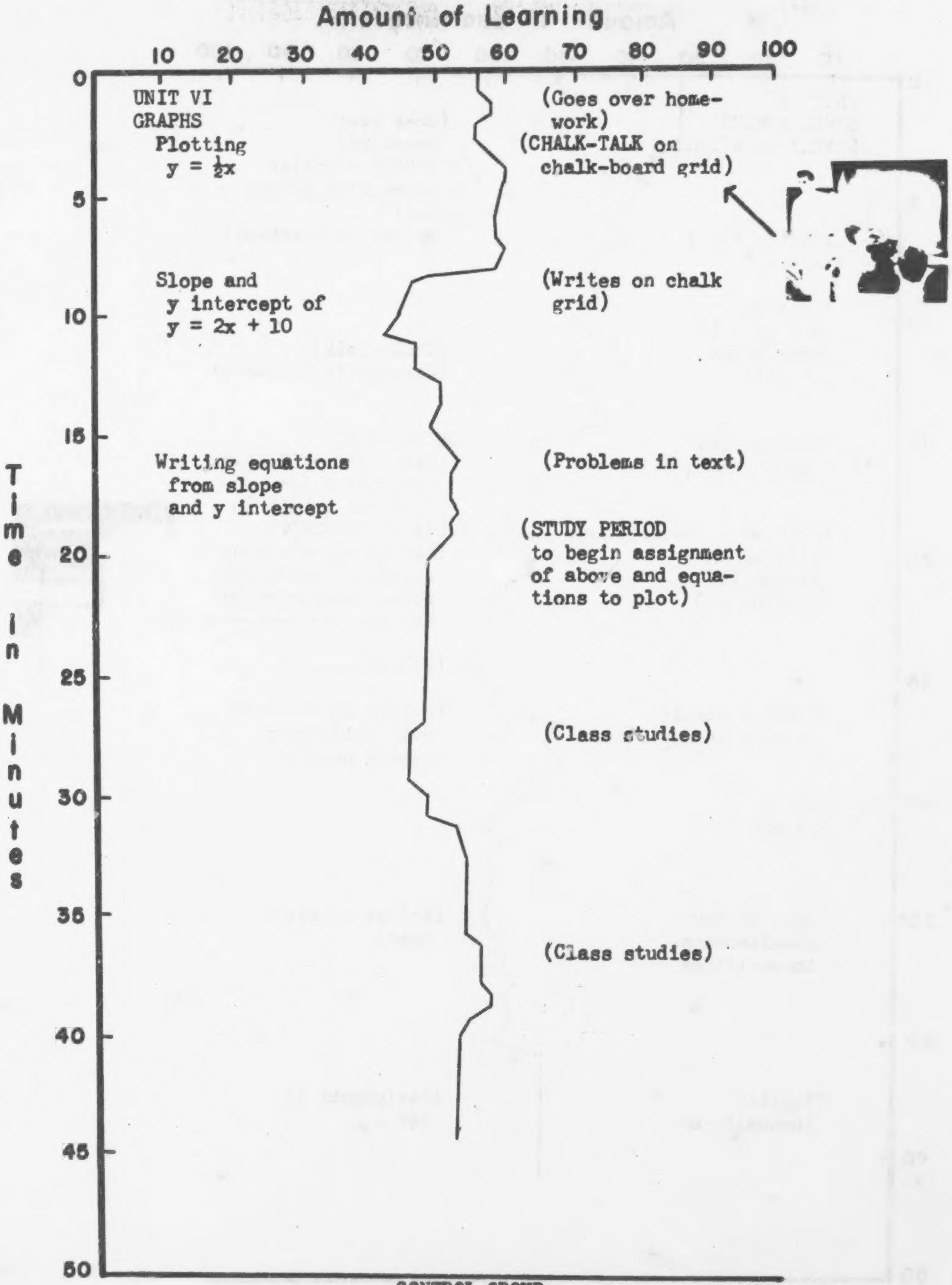
LEARNING PROFILE NUMBER 129





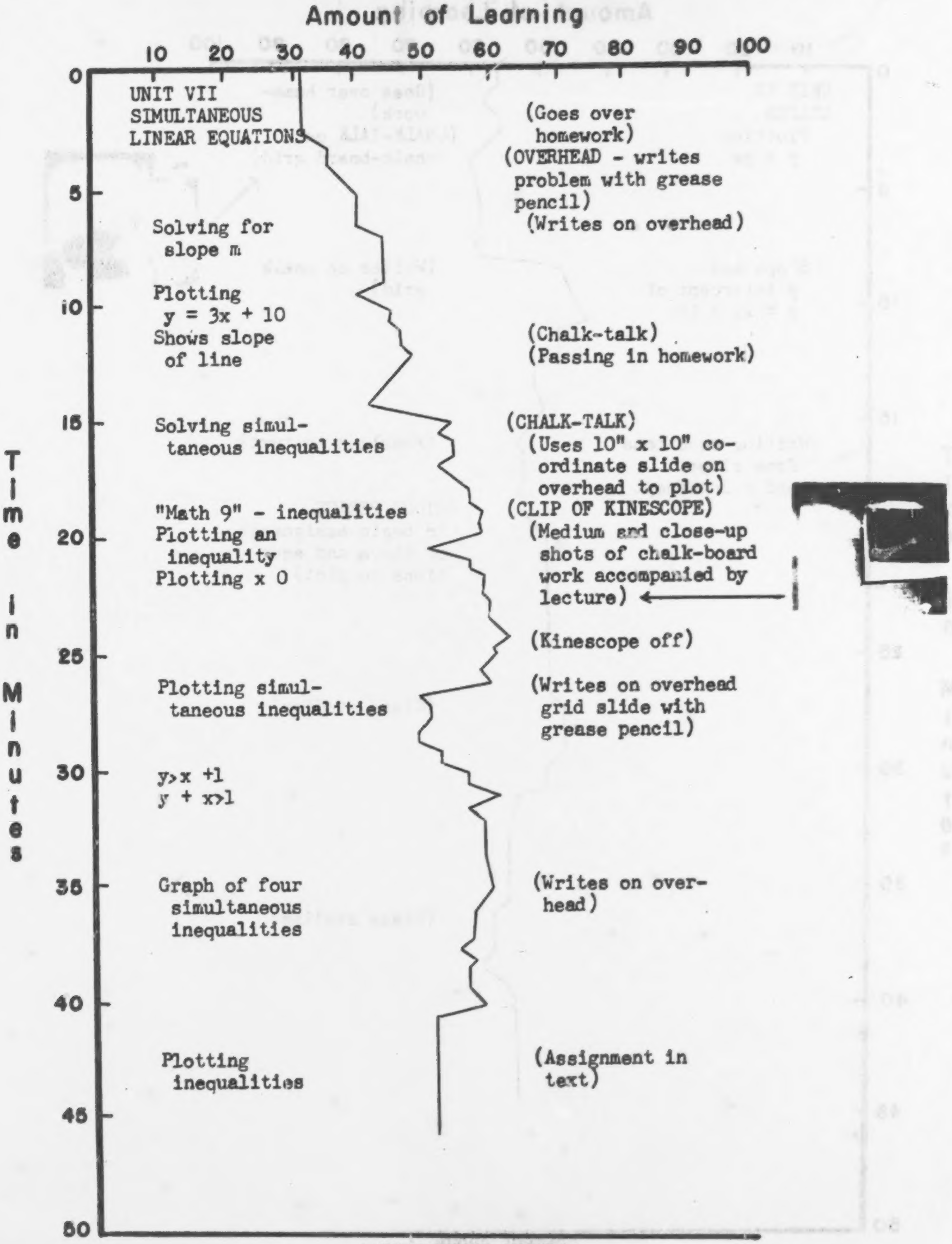
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 130



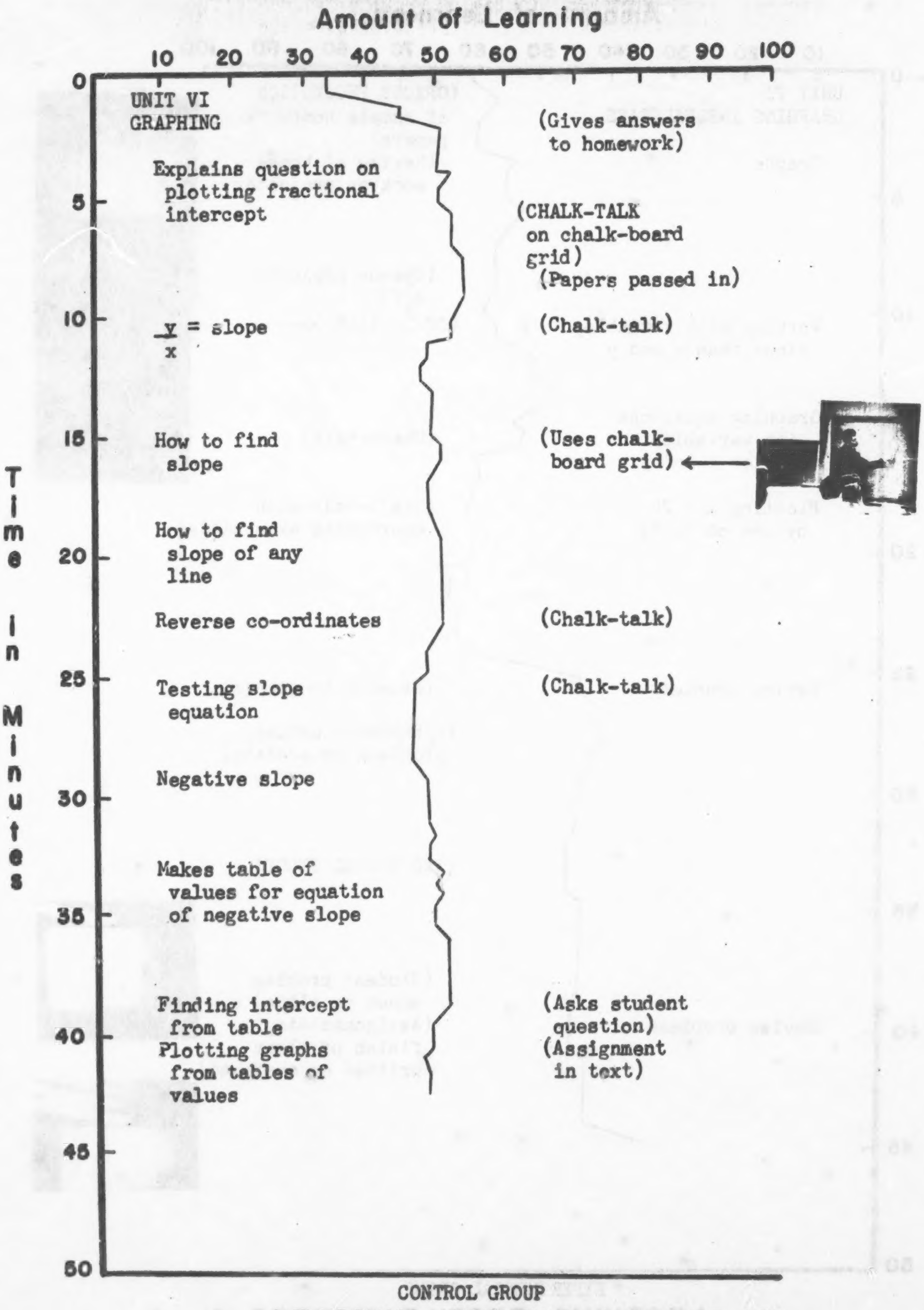
CONTROL GROUP

LEARNING PROFILE NUMBER 131



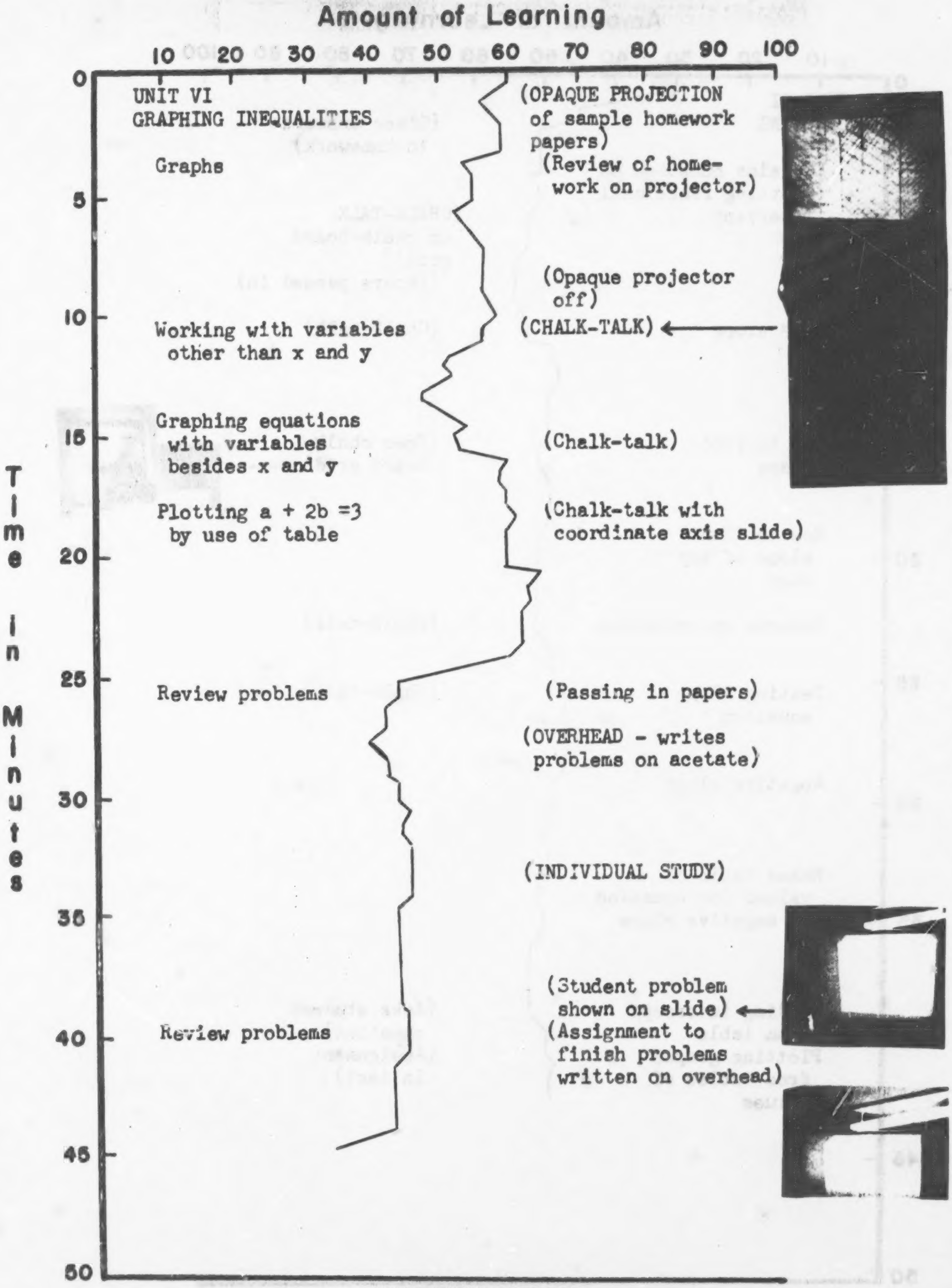
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 132



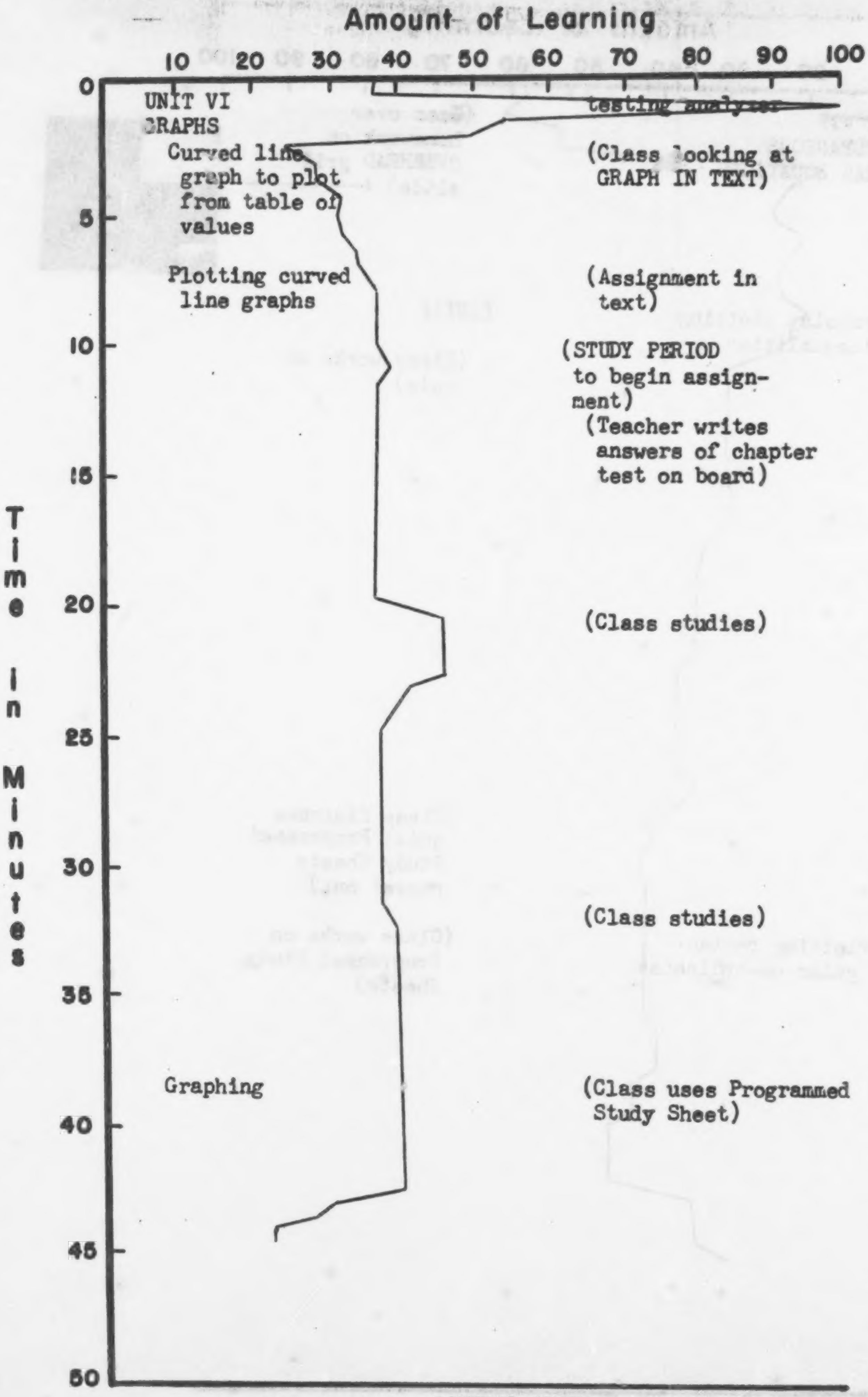
CONTROL GROUP

LEARNING PROFILE NUMBER 133



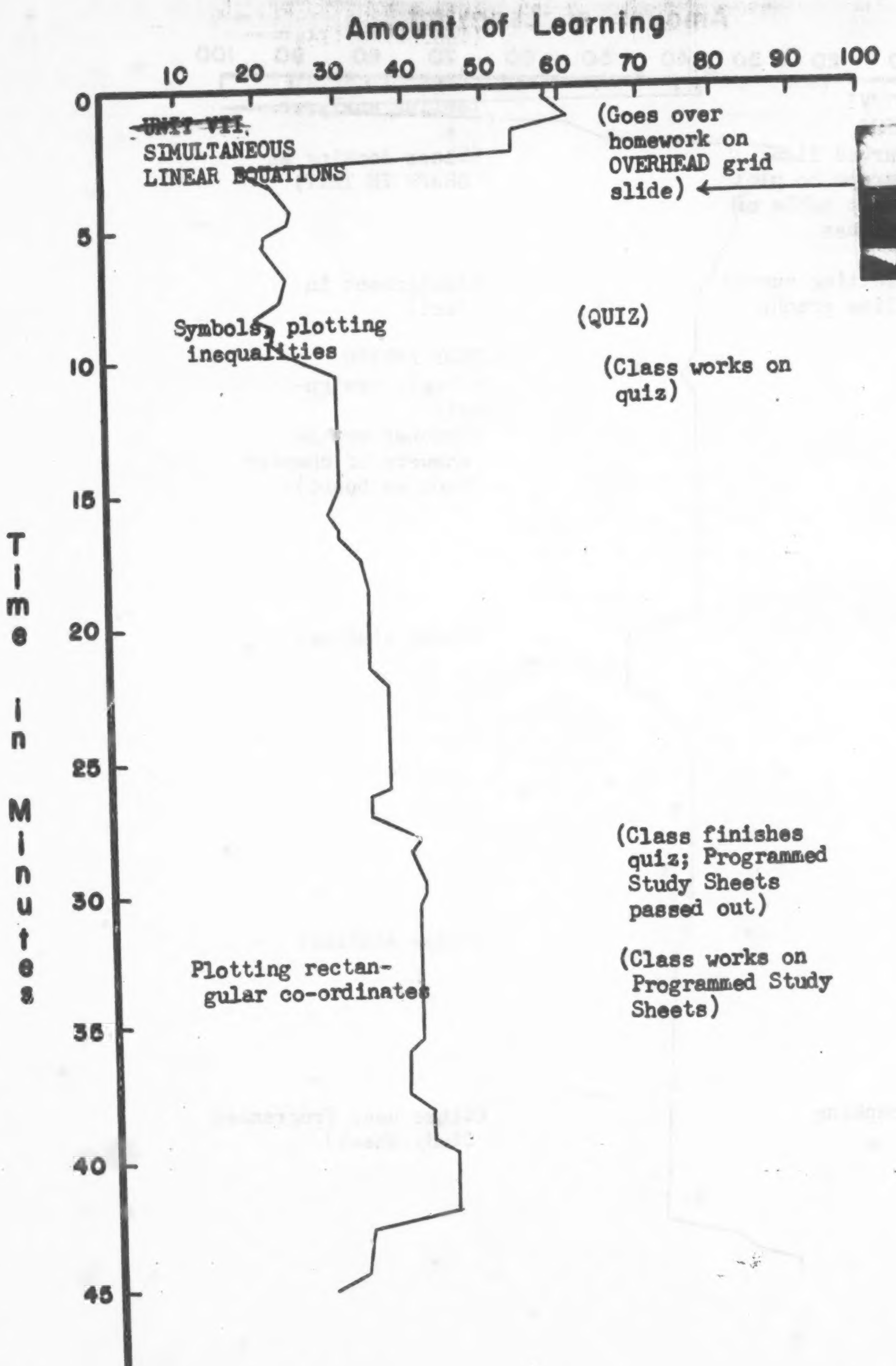
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 134



CONTROL GROUP

LEARNING PROFILE NUMBER 135



EXPERIMENTAL GROUP

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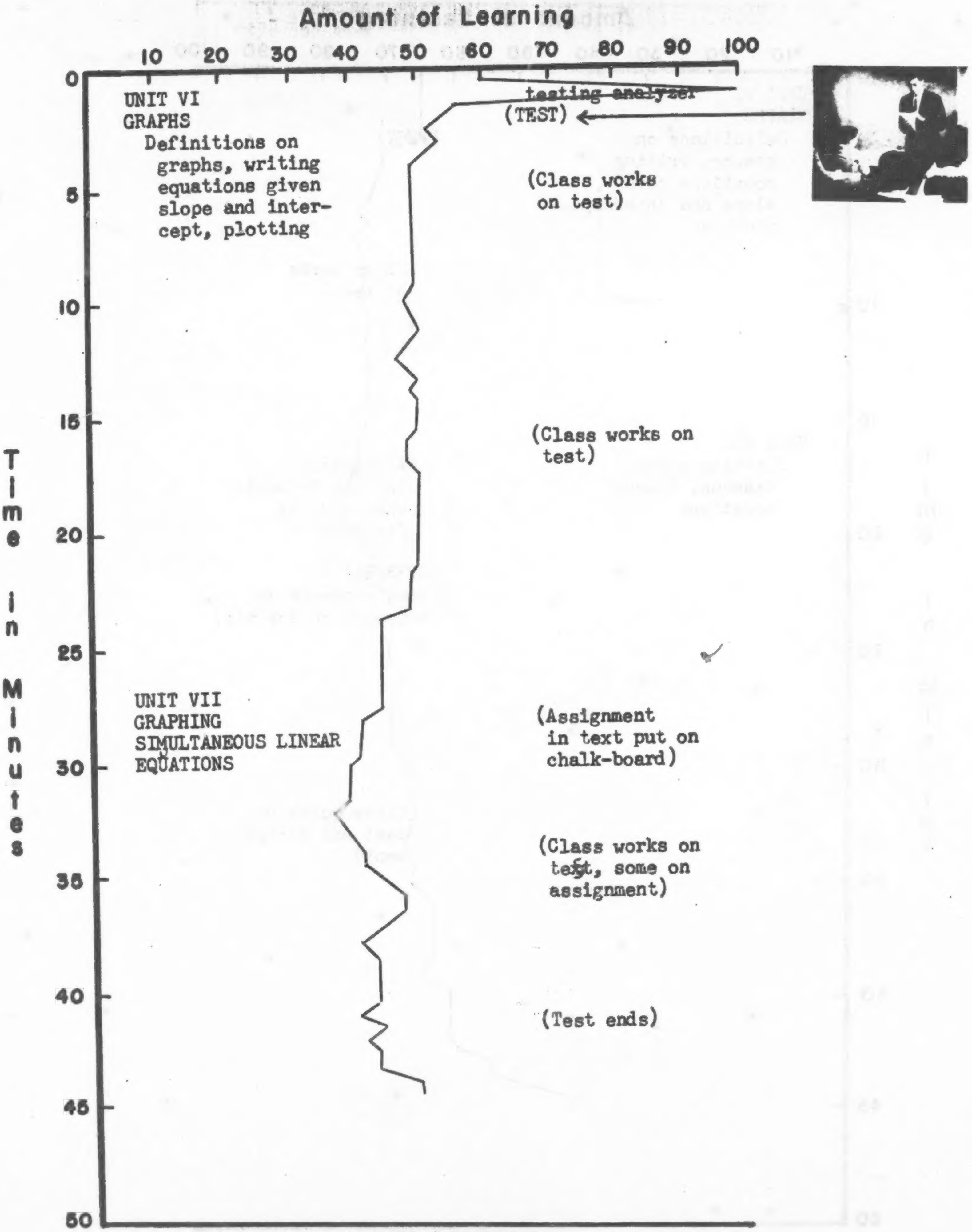

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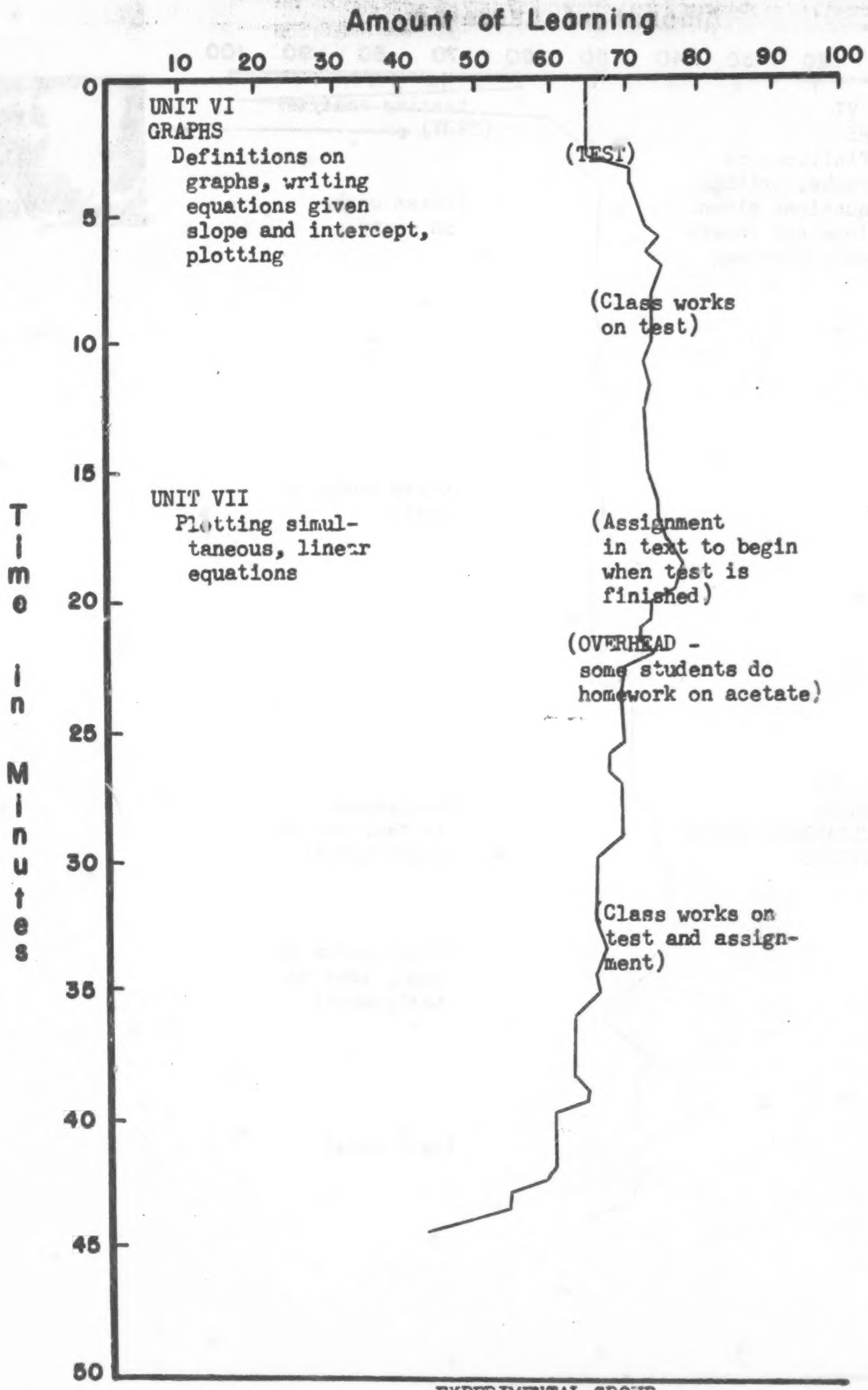

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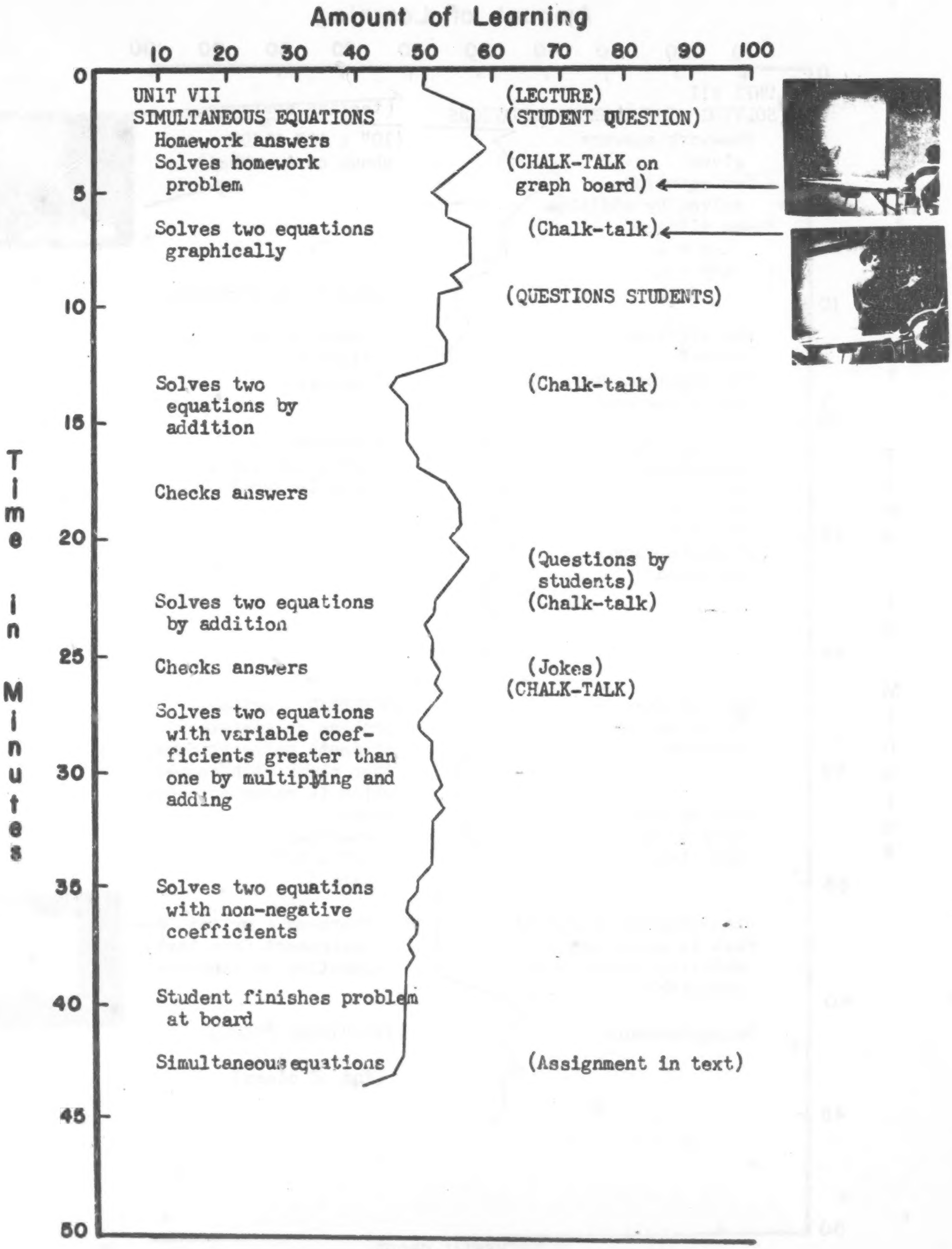

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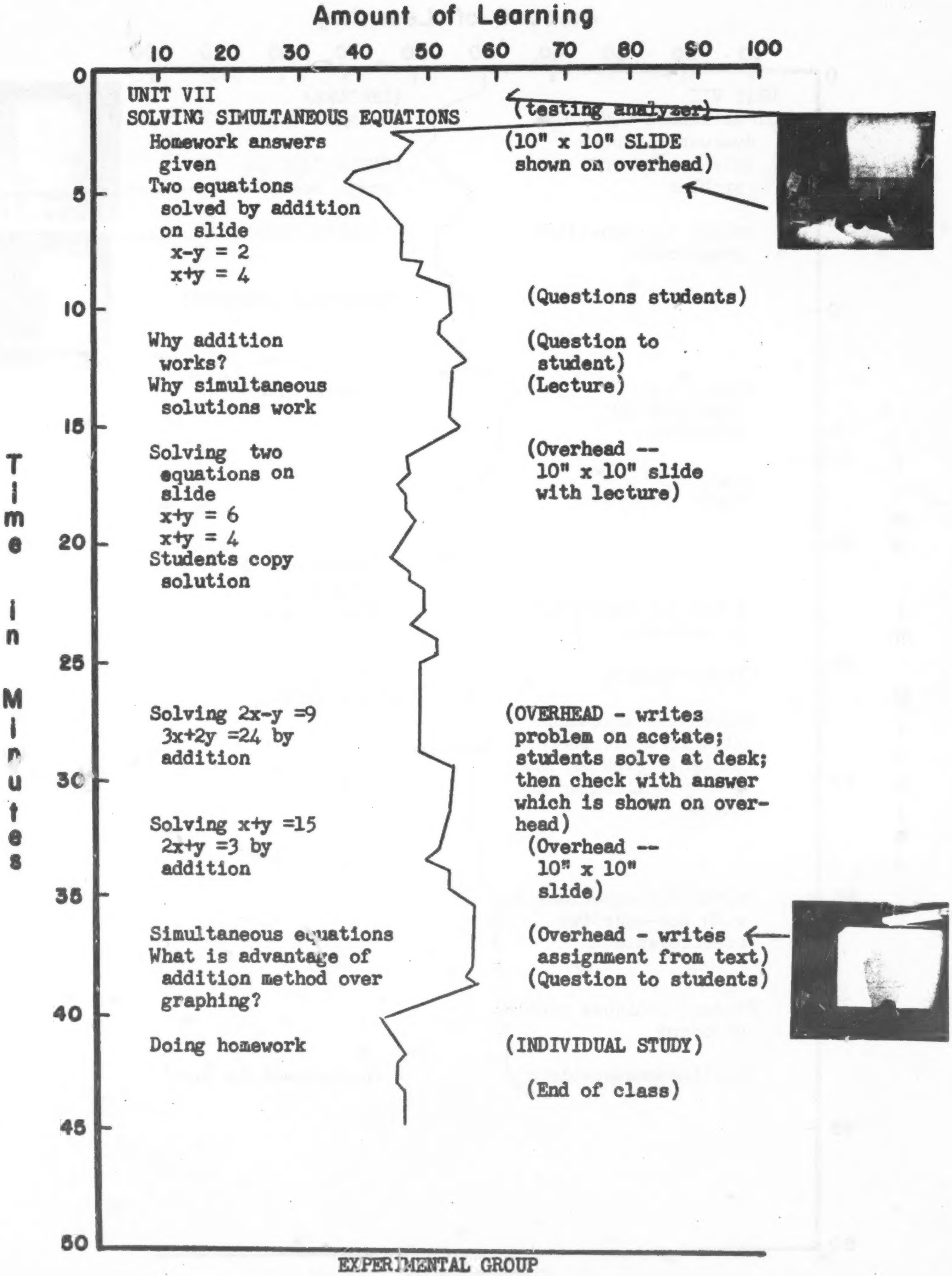

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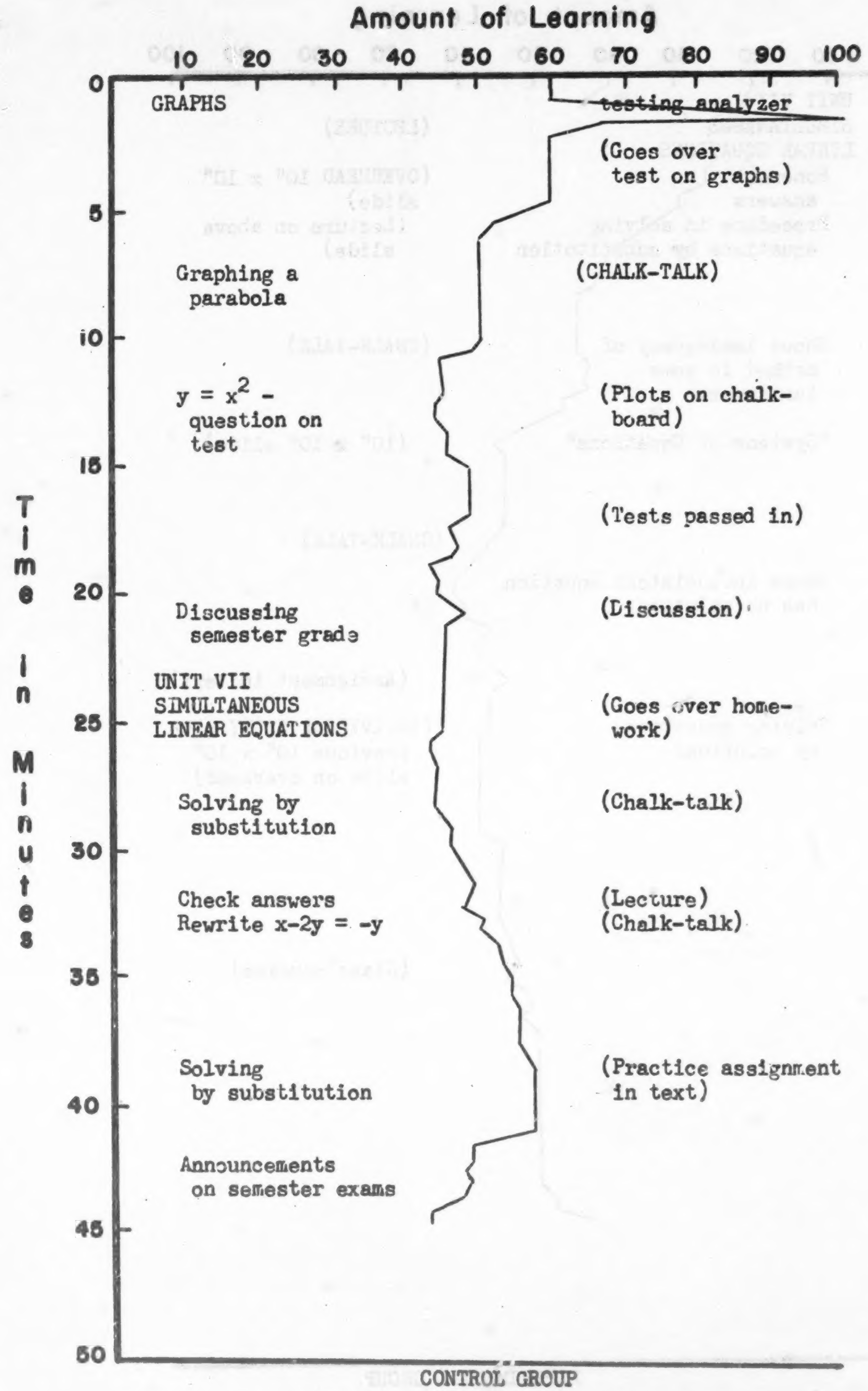

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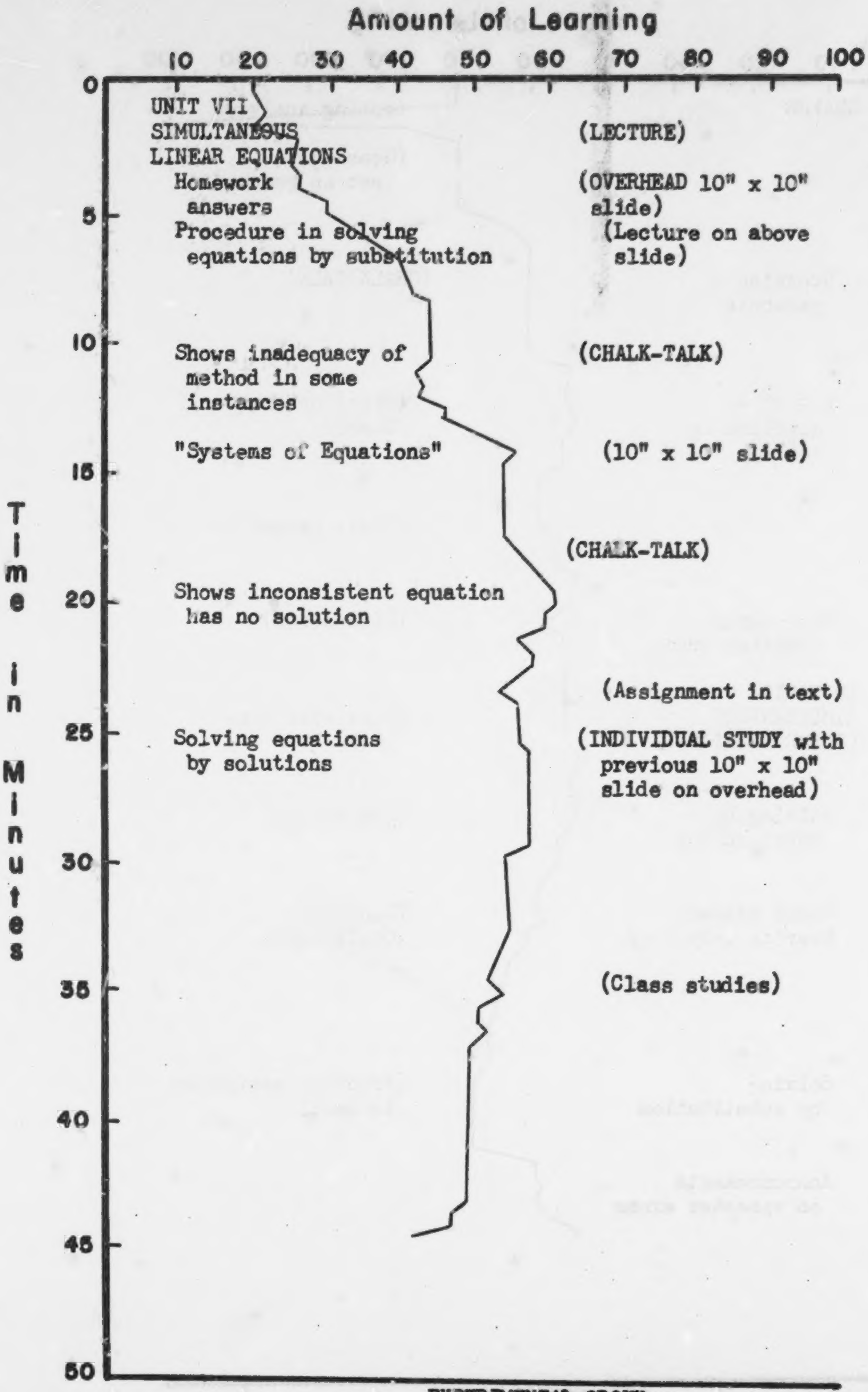

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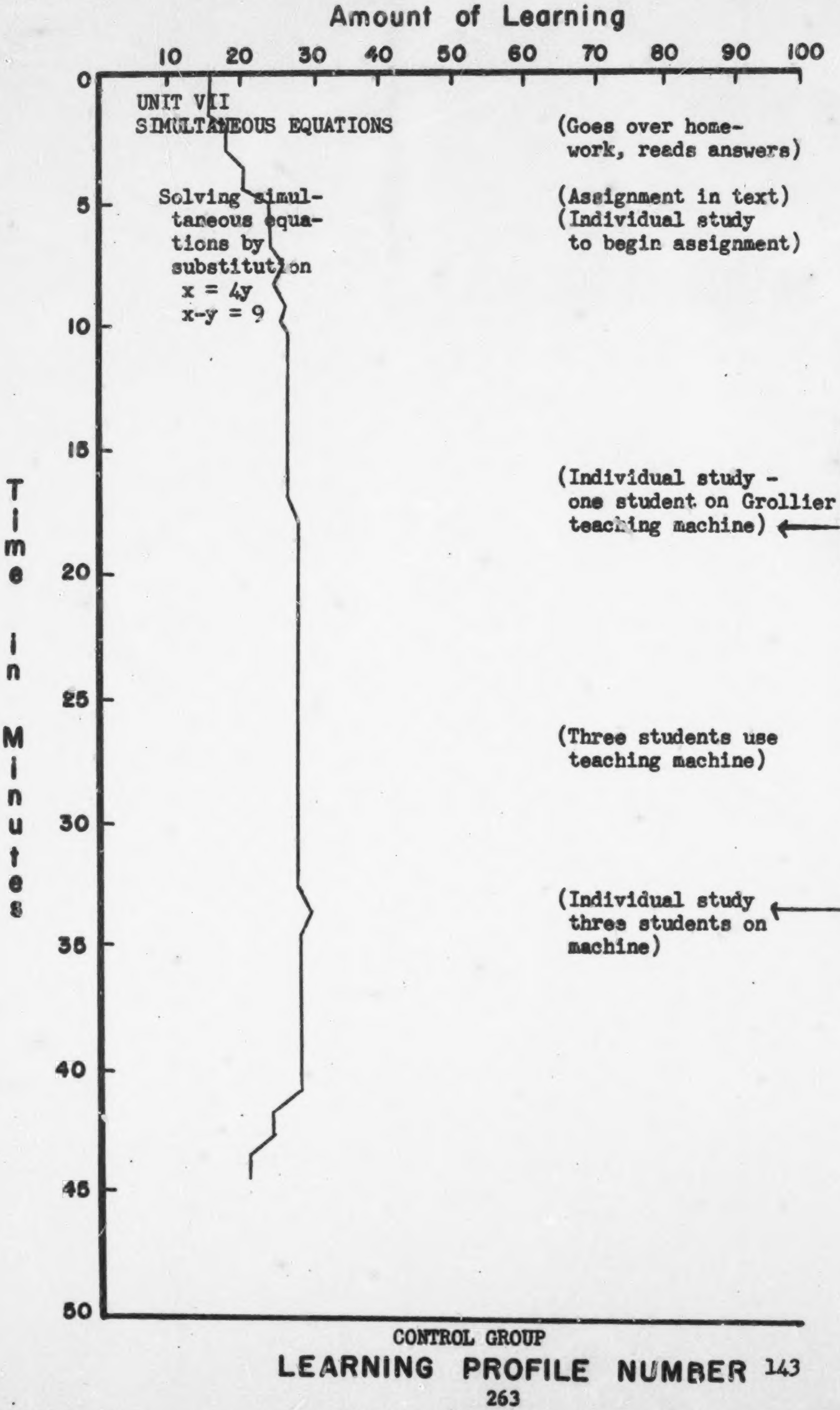
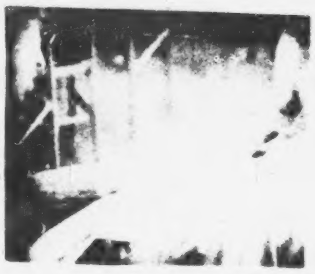


(Goes over homework, reads answers)

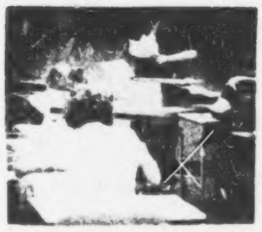
(Assignment in text)
(Individual study to begin assignment)

(Individual study - one student on Grollier teaching machine)



(Three students use teaching machine)

(Individual study three students on machine)



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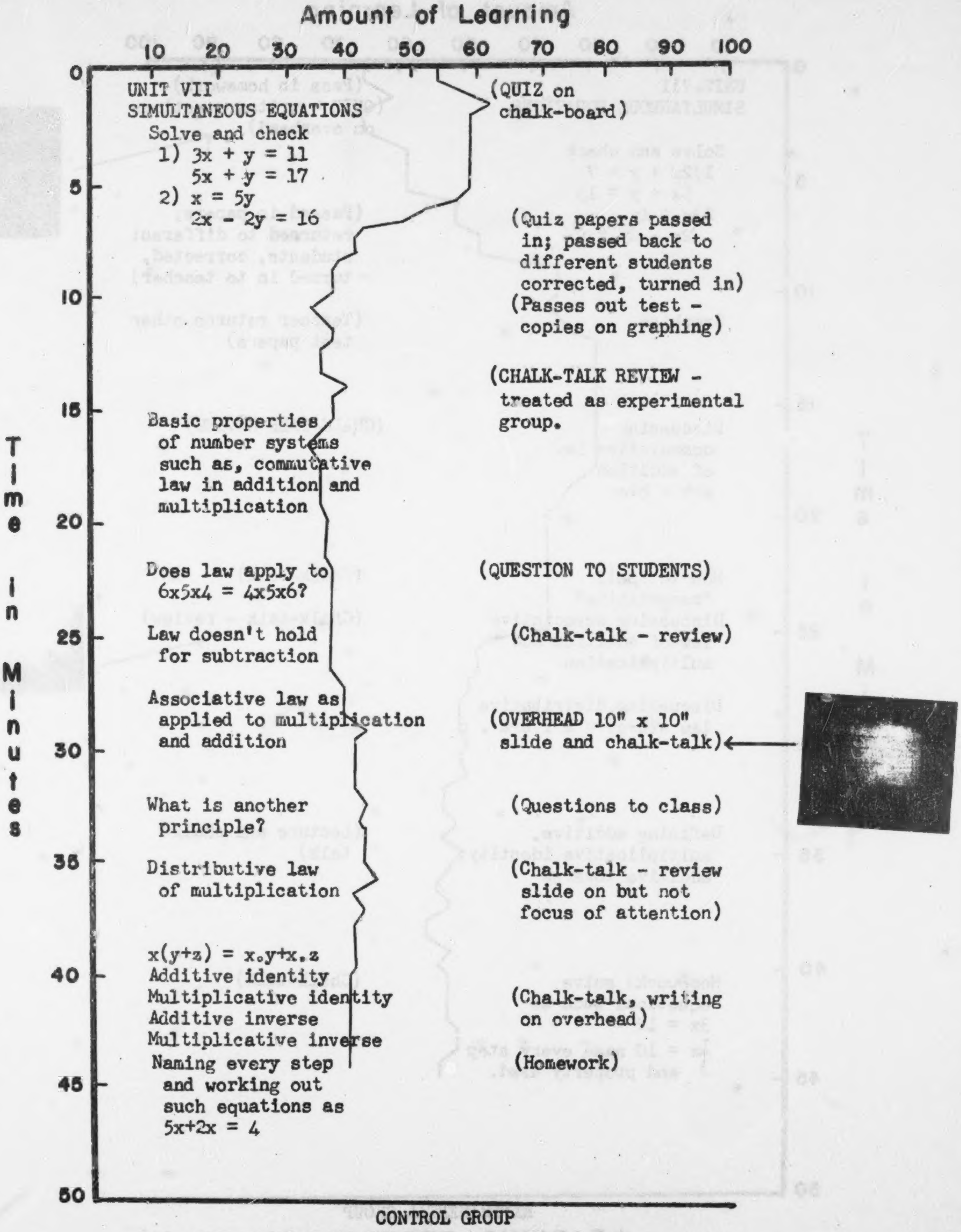

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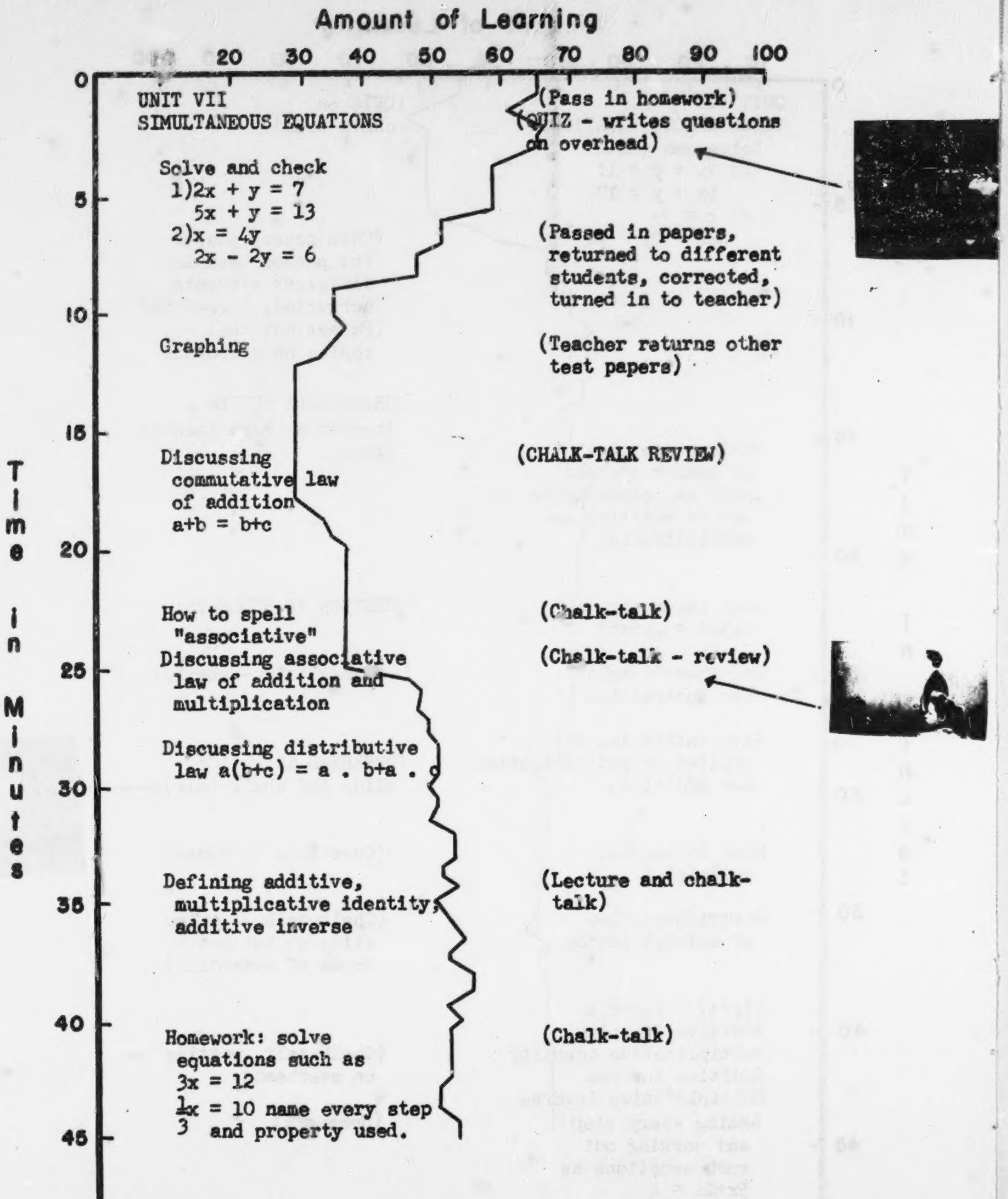

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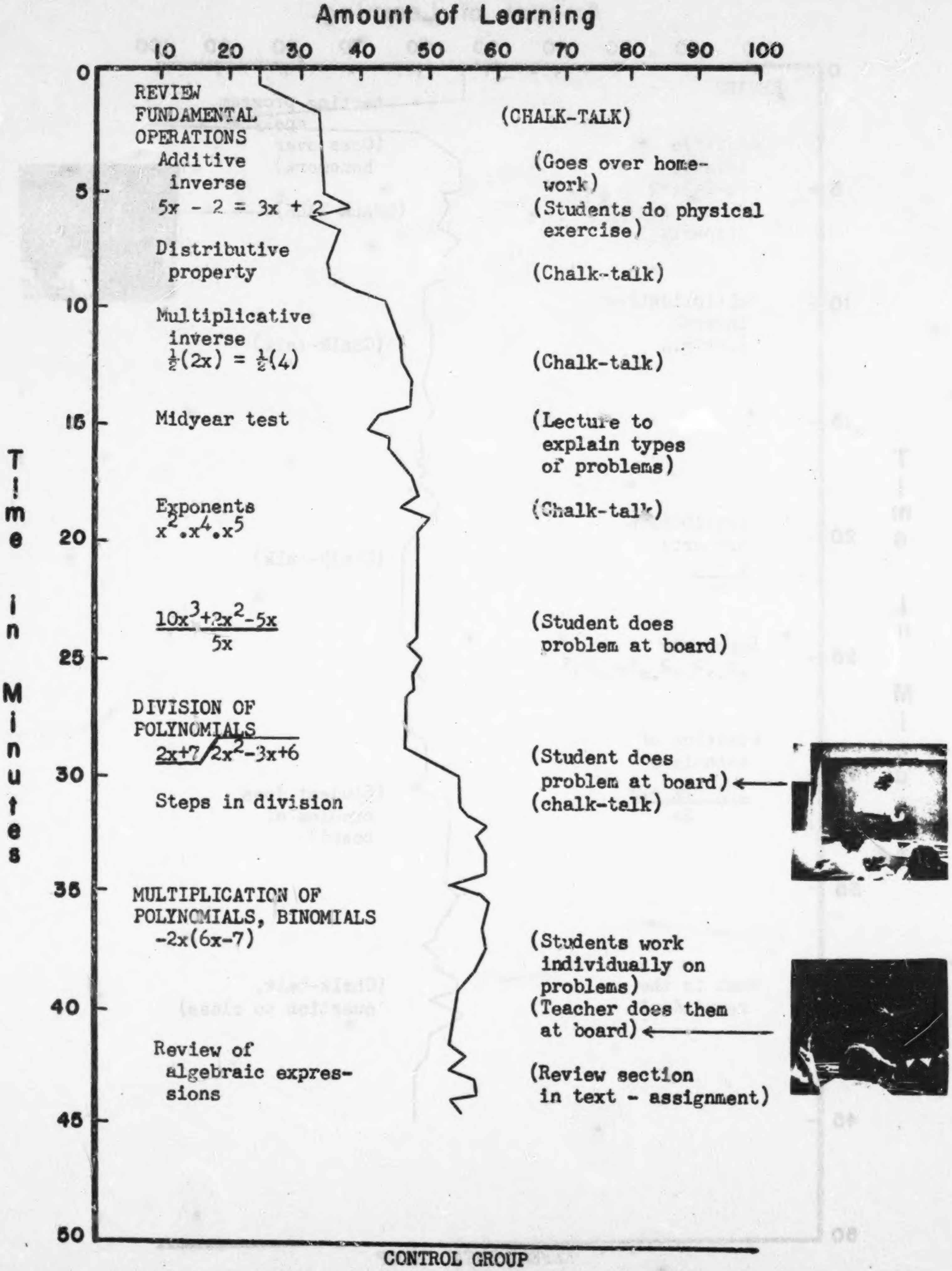

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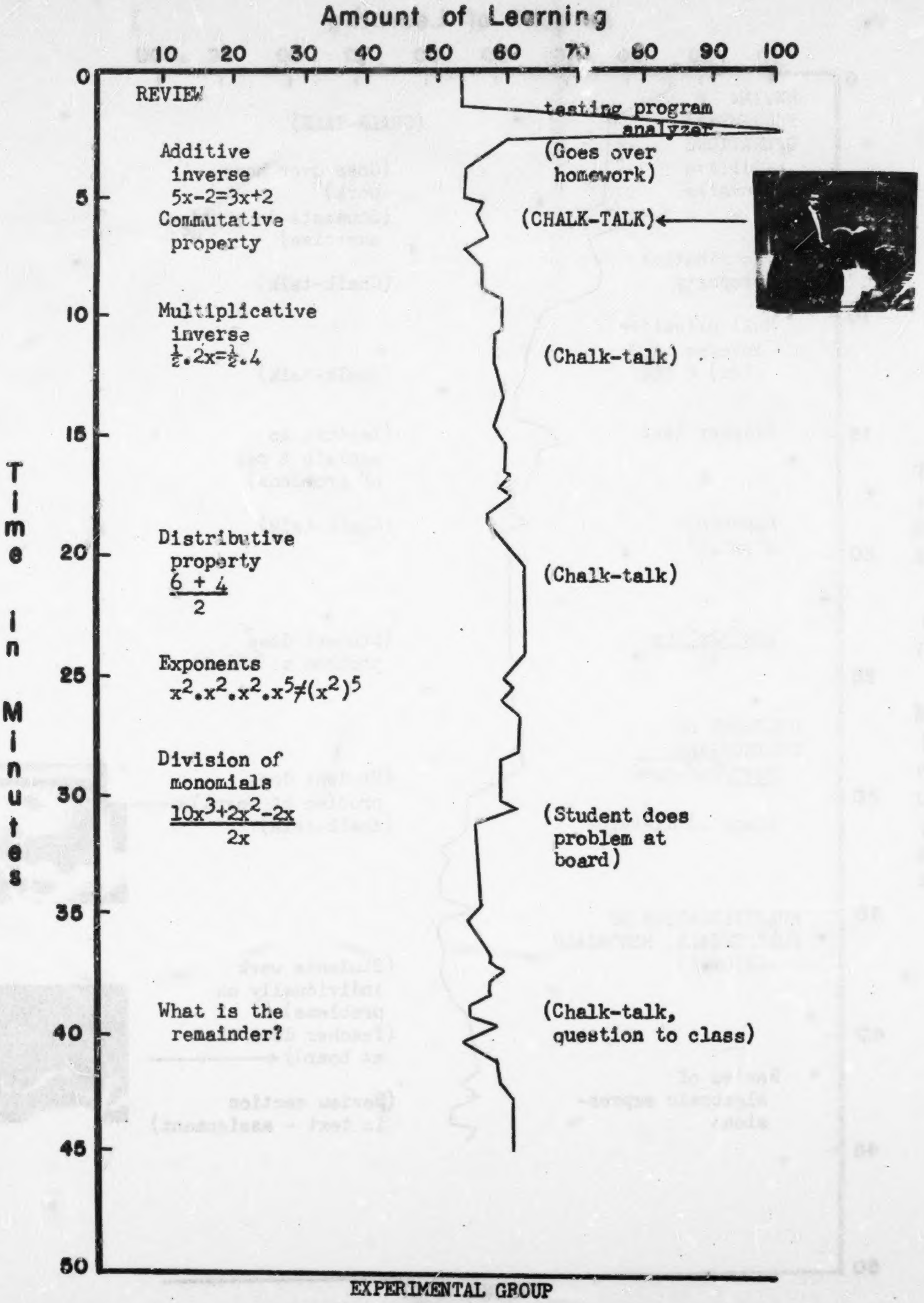

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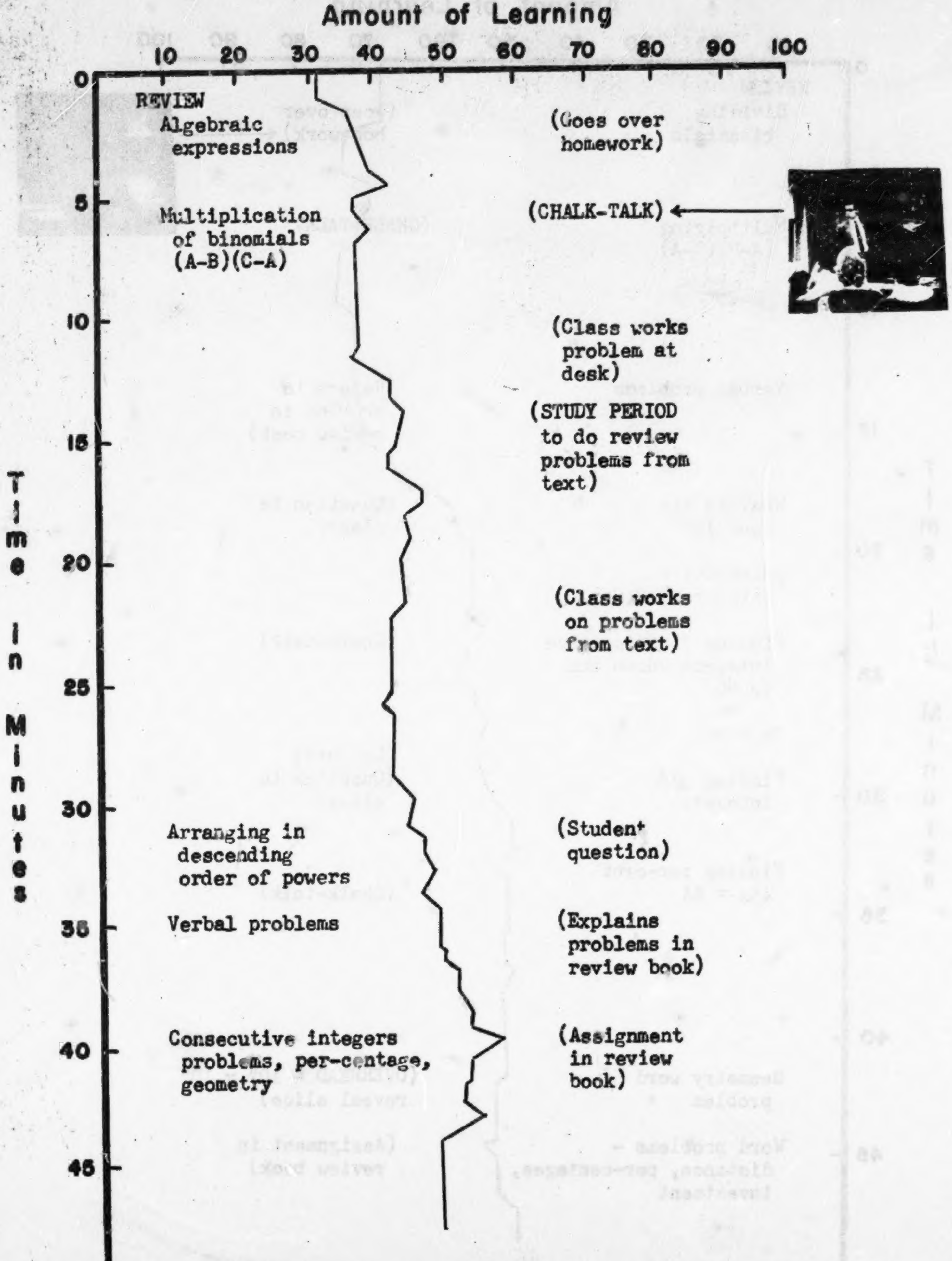

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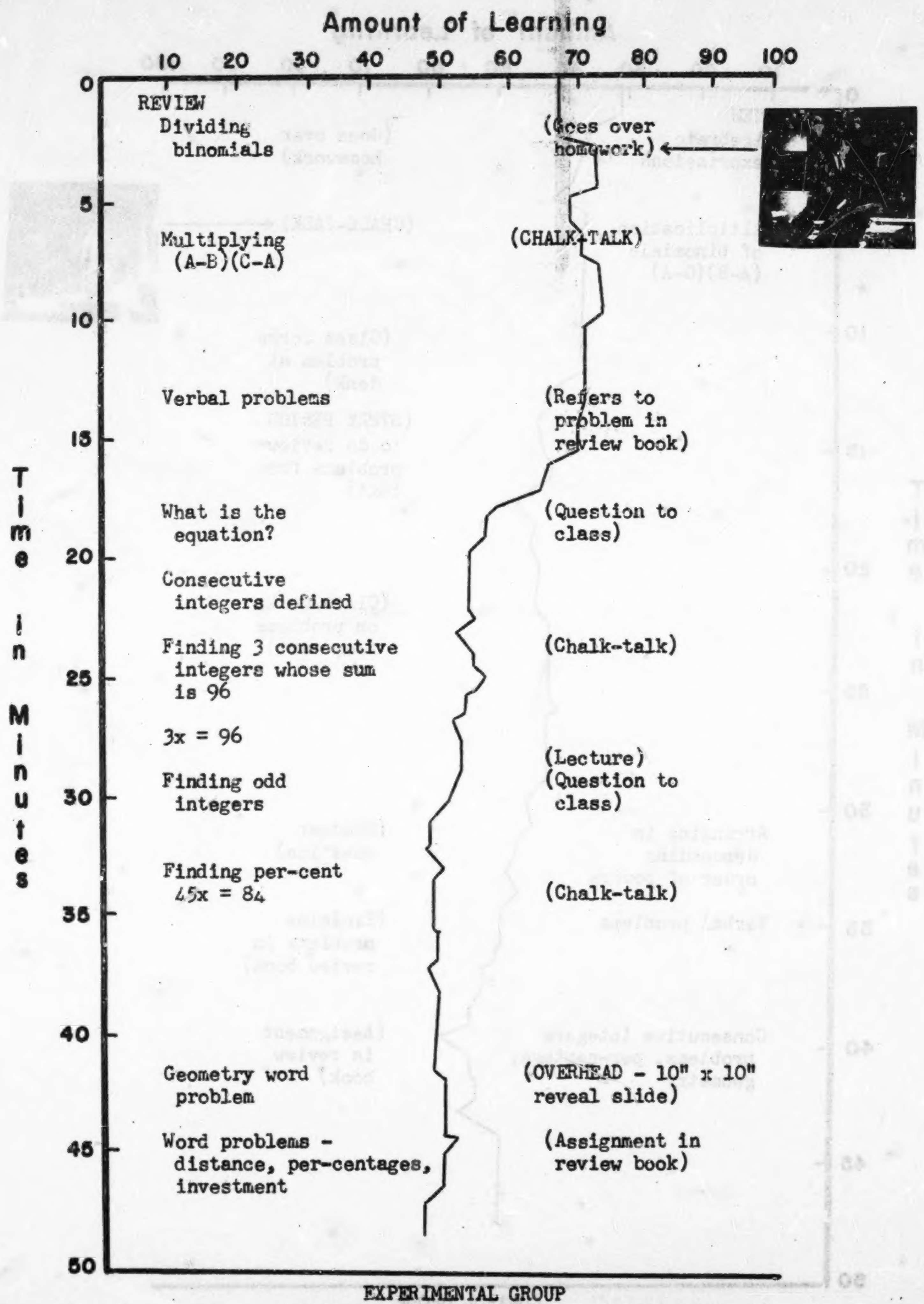

EXPERIMENTAL GROUP

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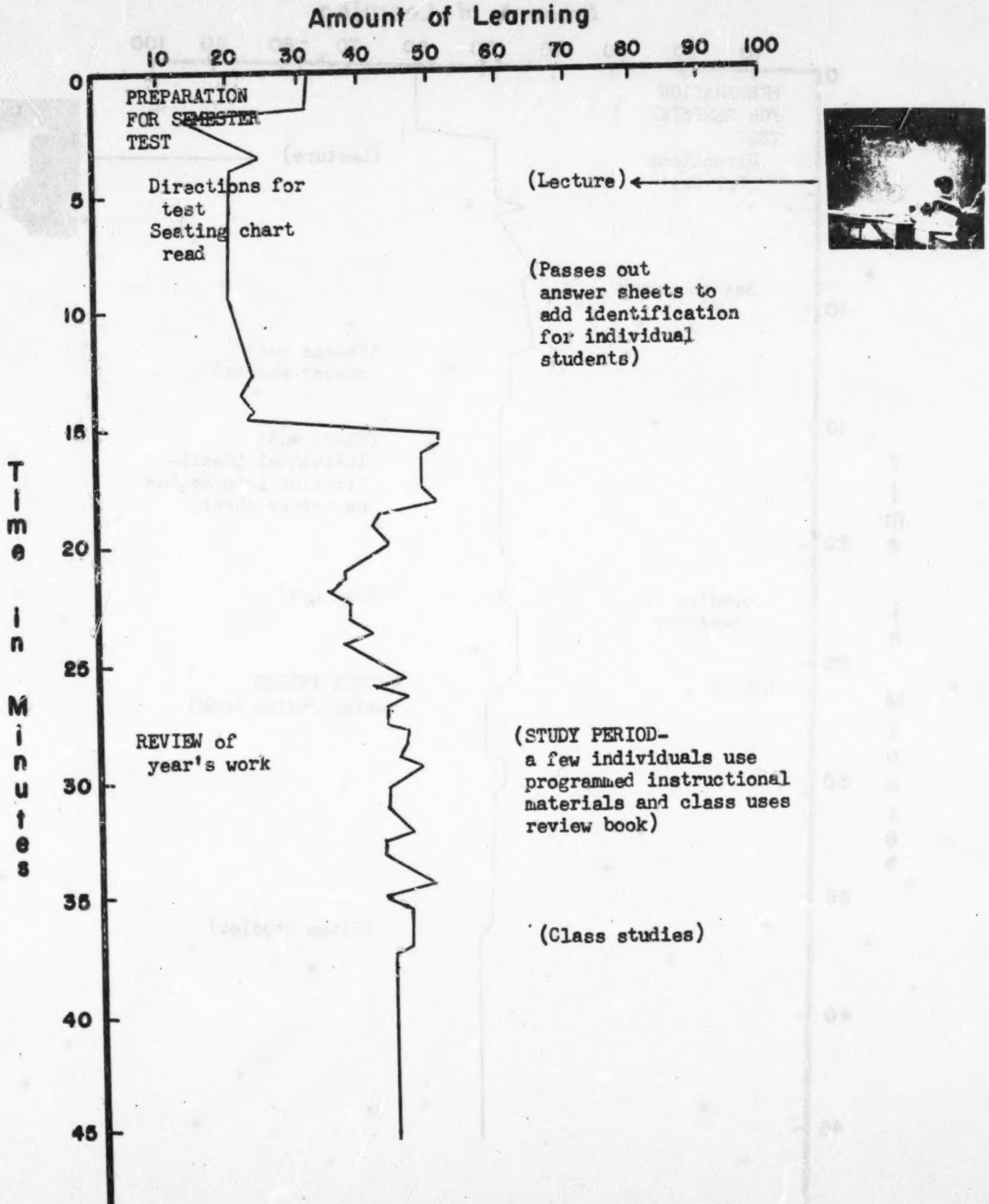

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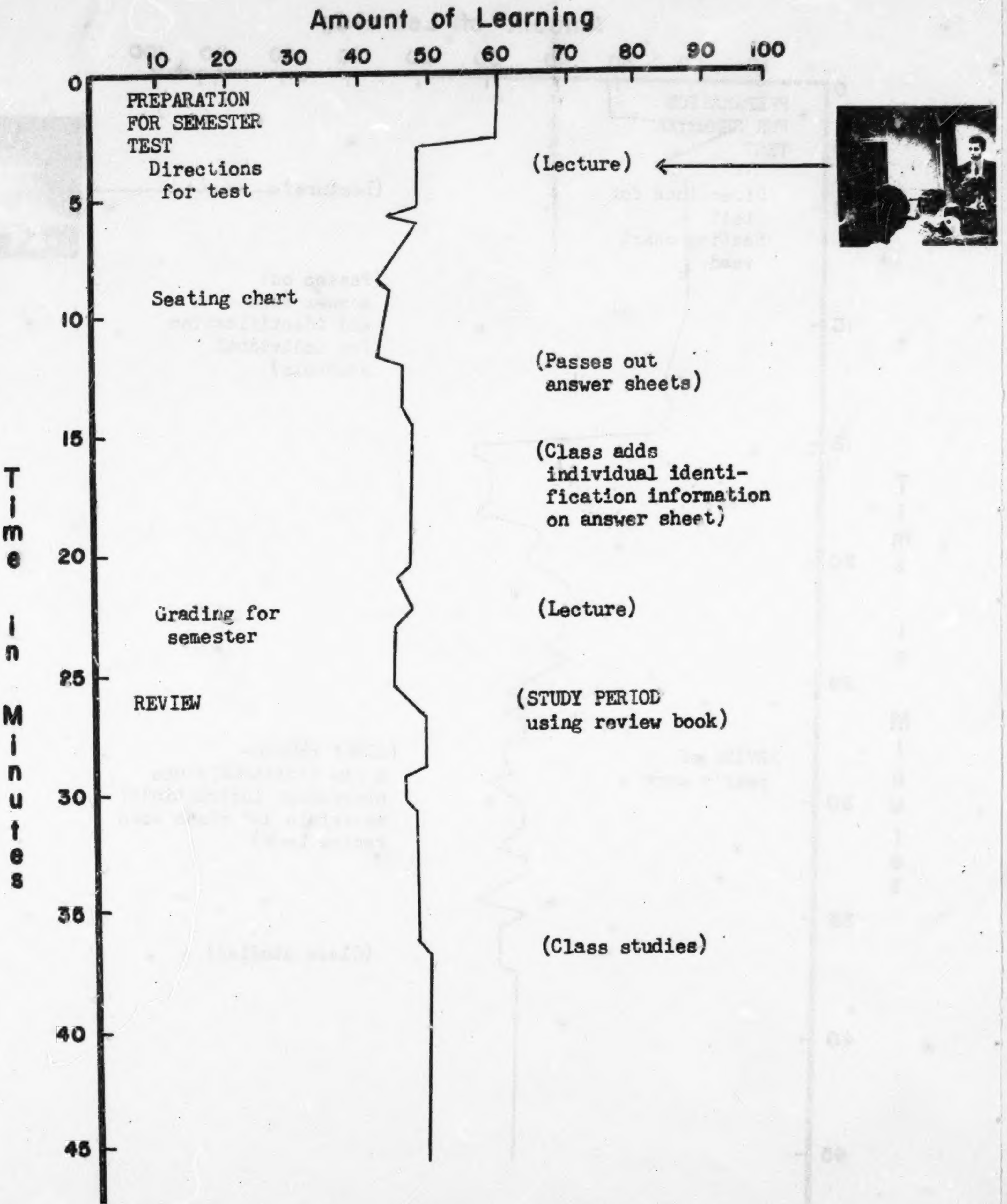

EXPERIMENTAL GROUP

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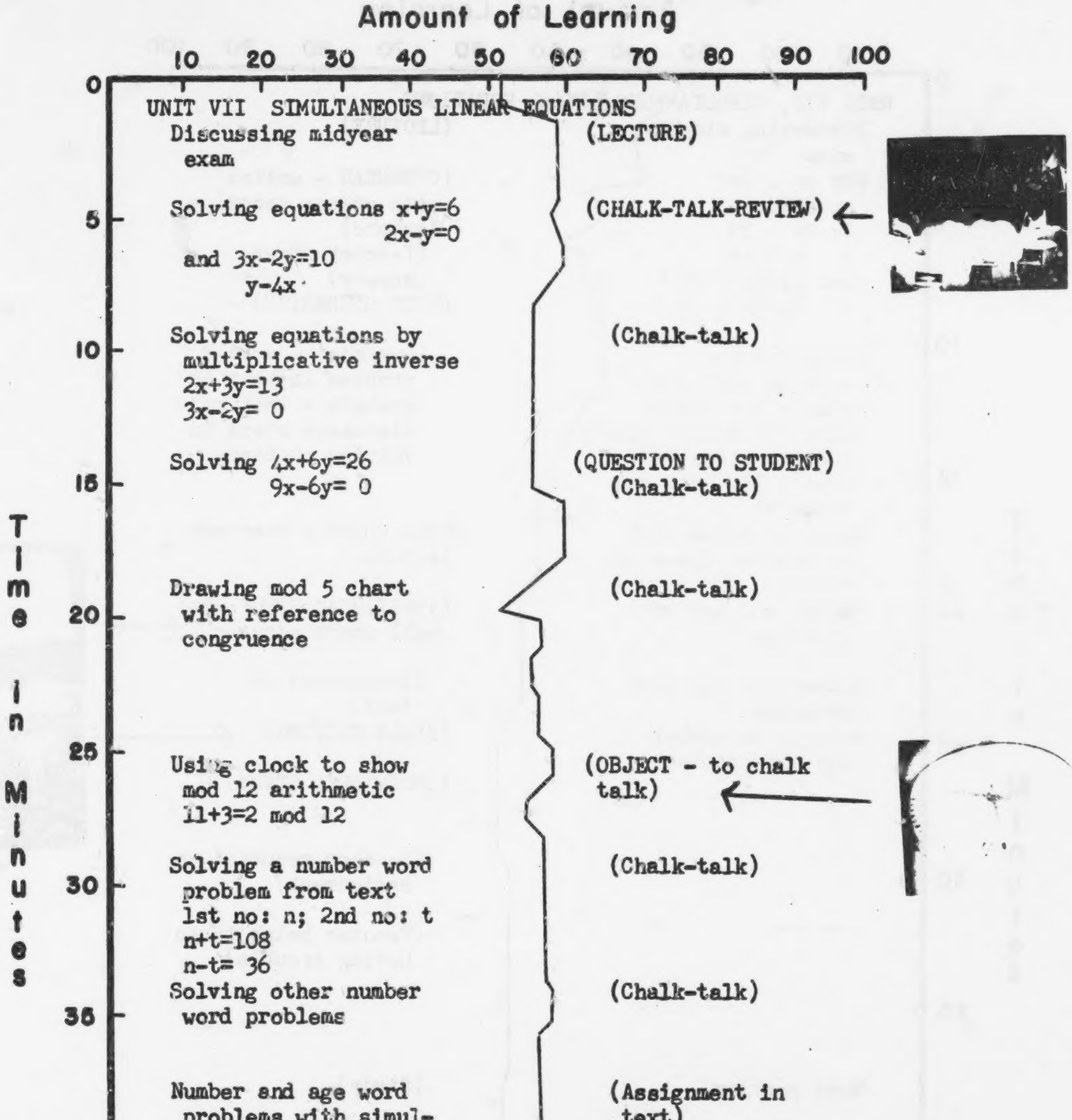

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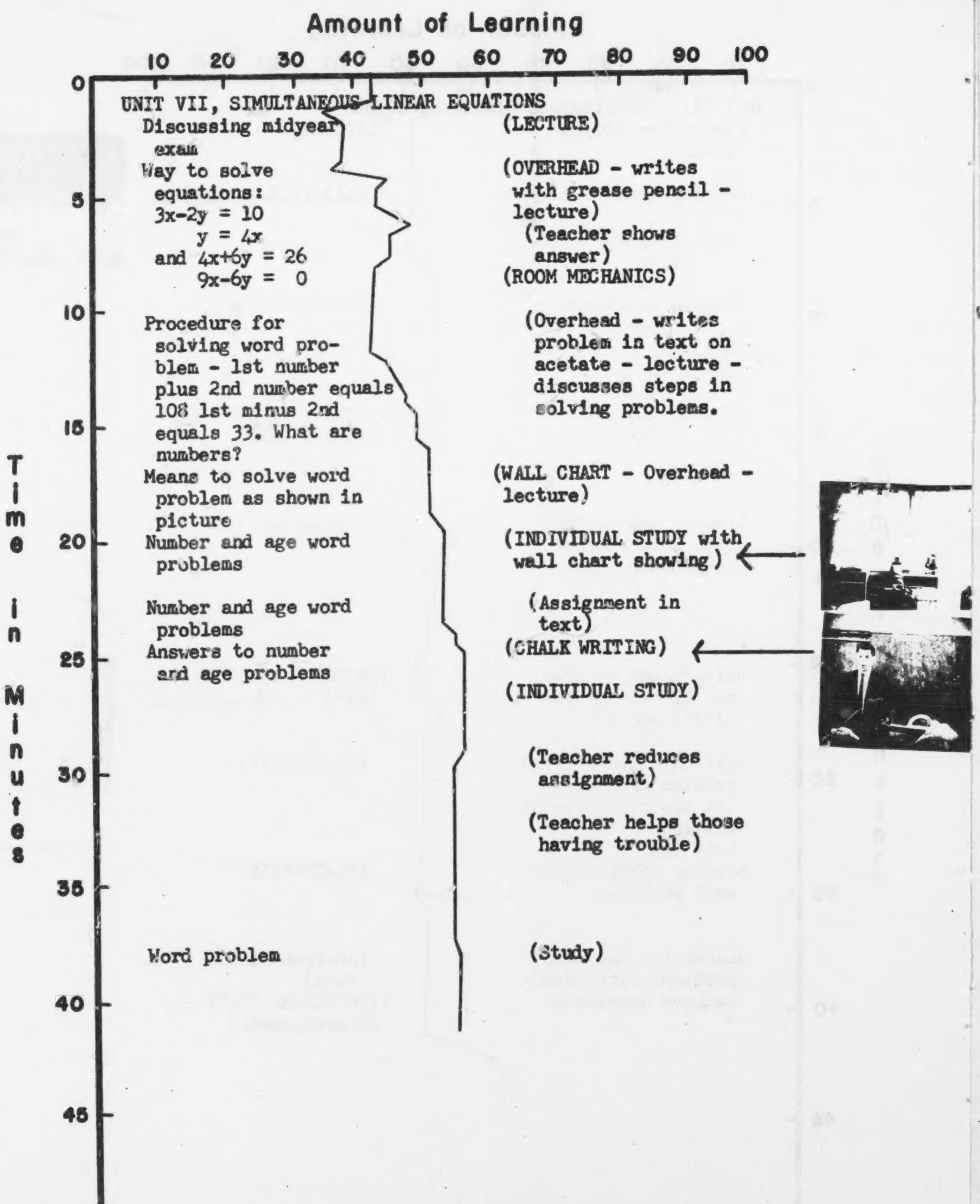

EXPERIMENTAL GROUP

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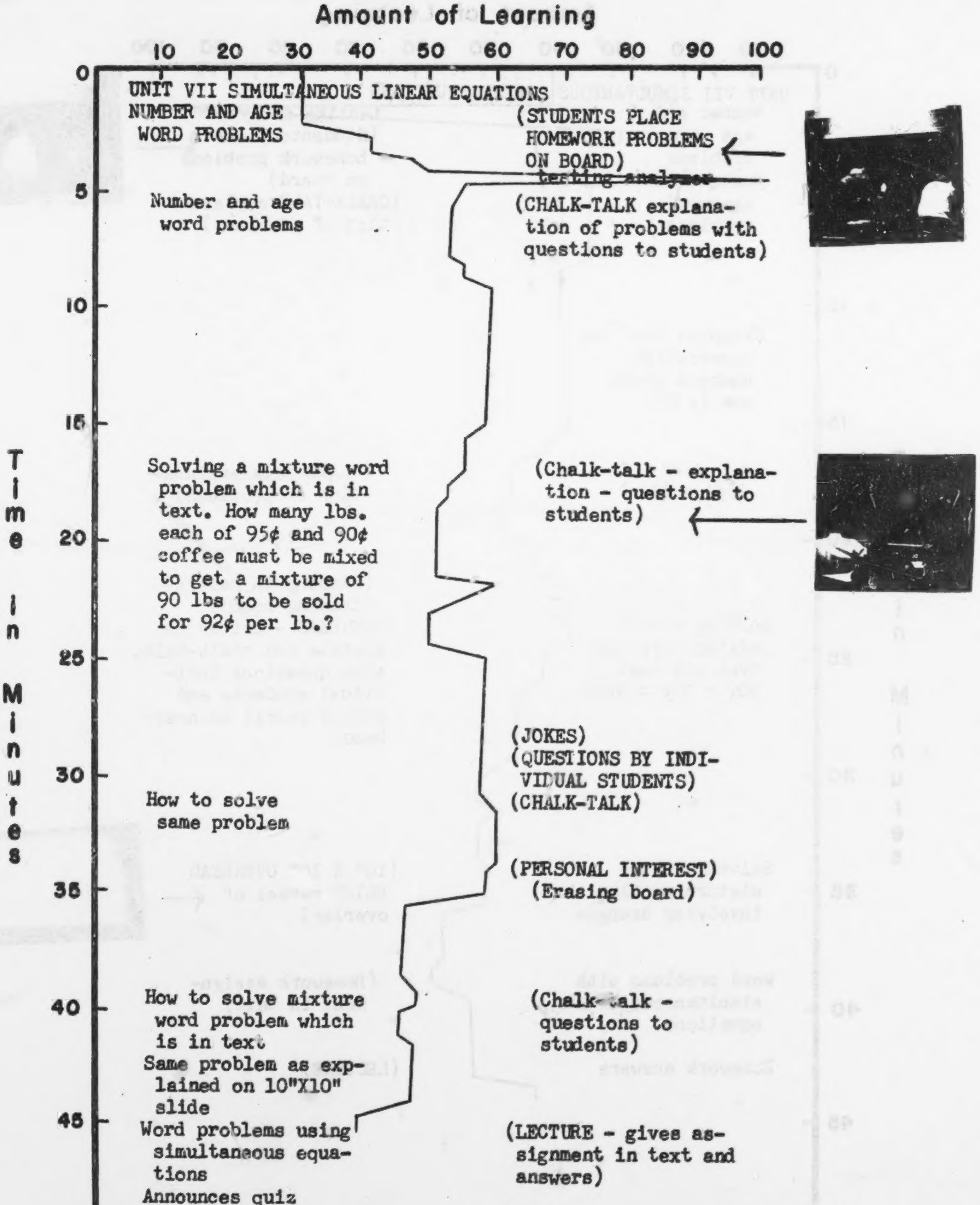

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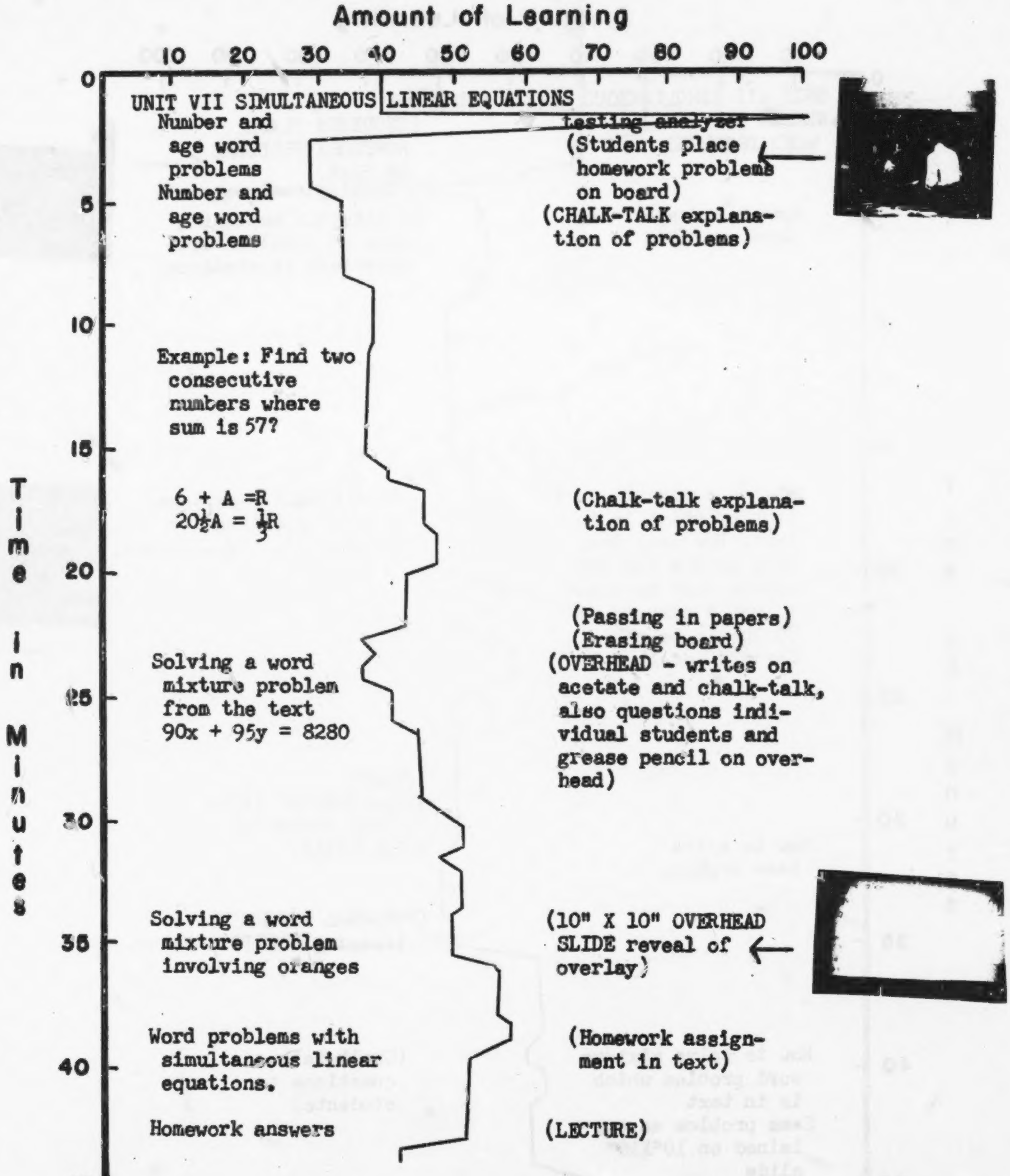

EXPERIMENTAL GROUP

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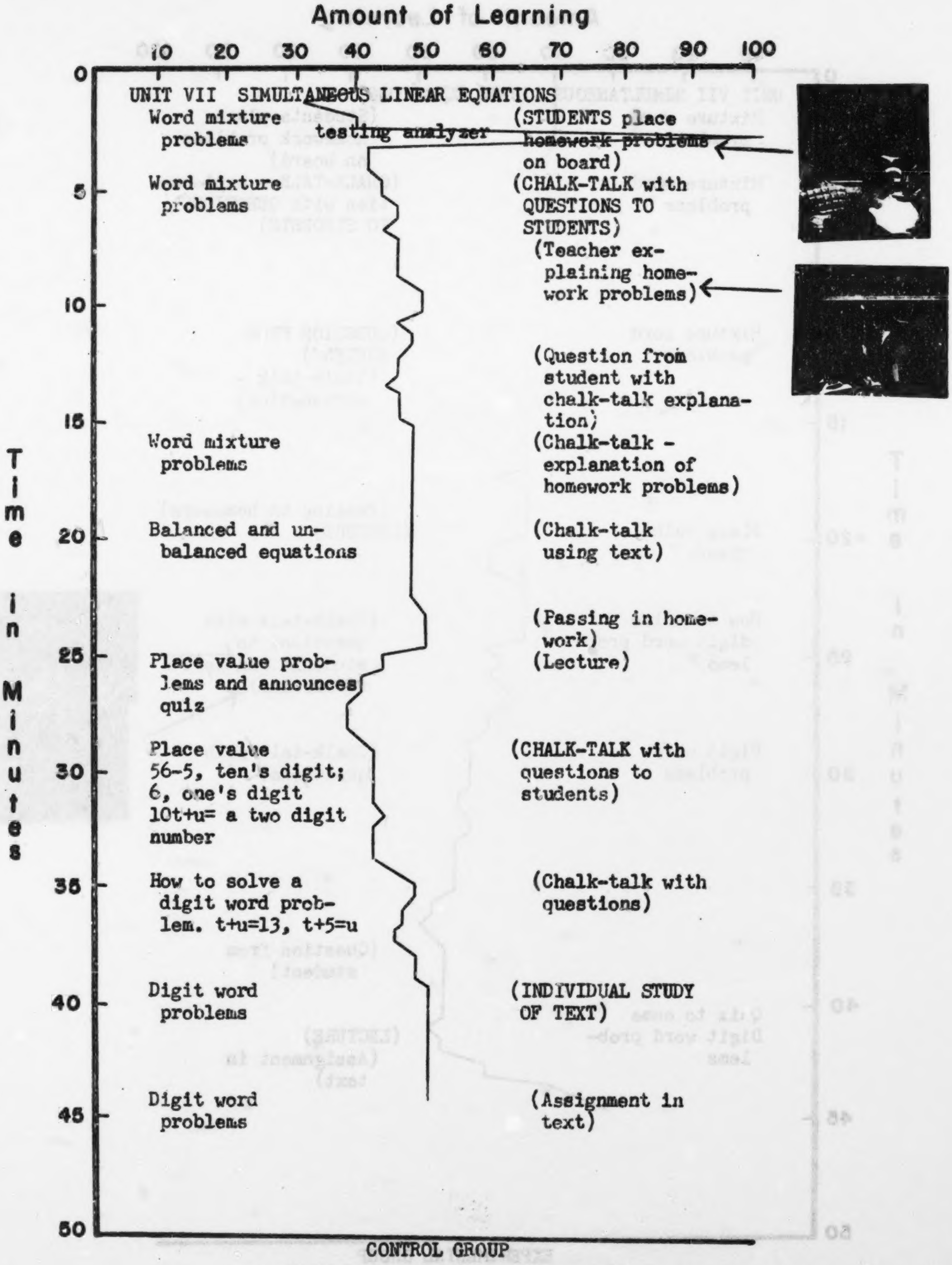

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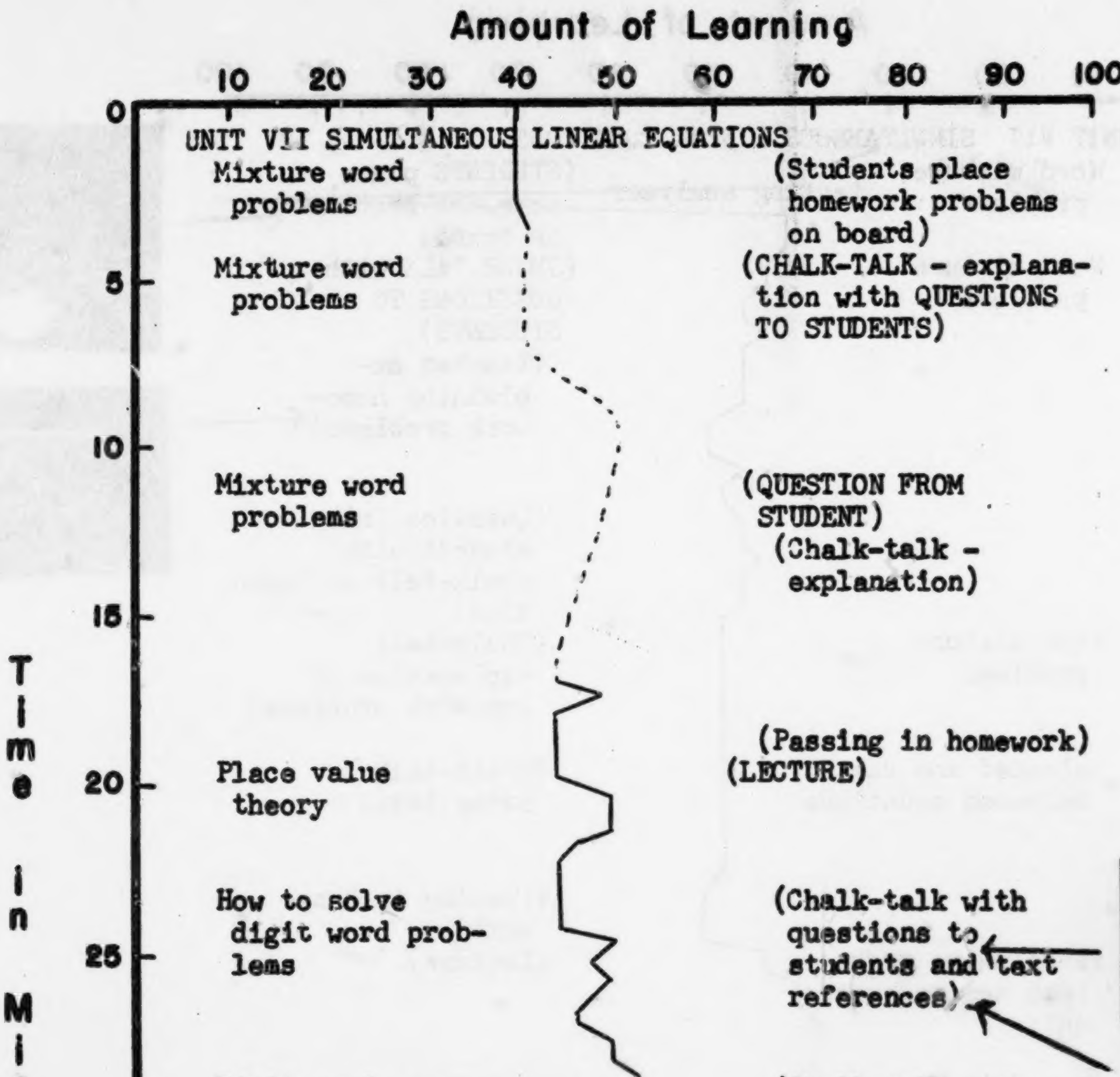

EXPERIMENTAL GROUP

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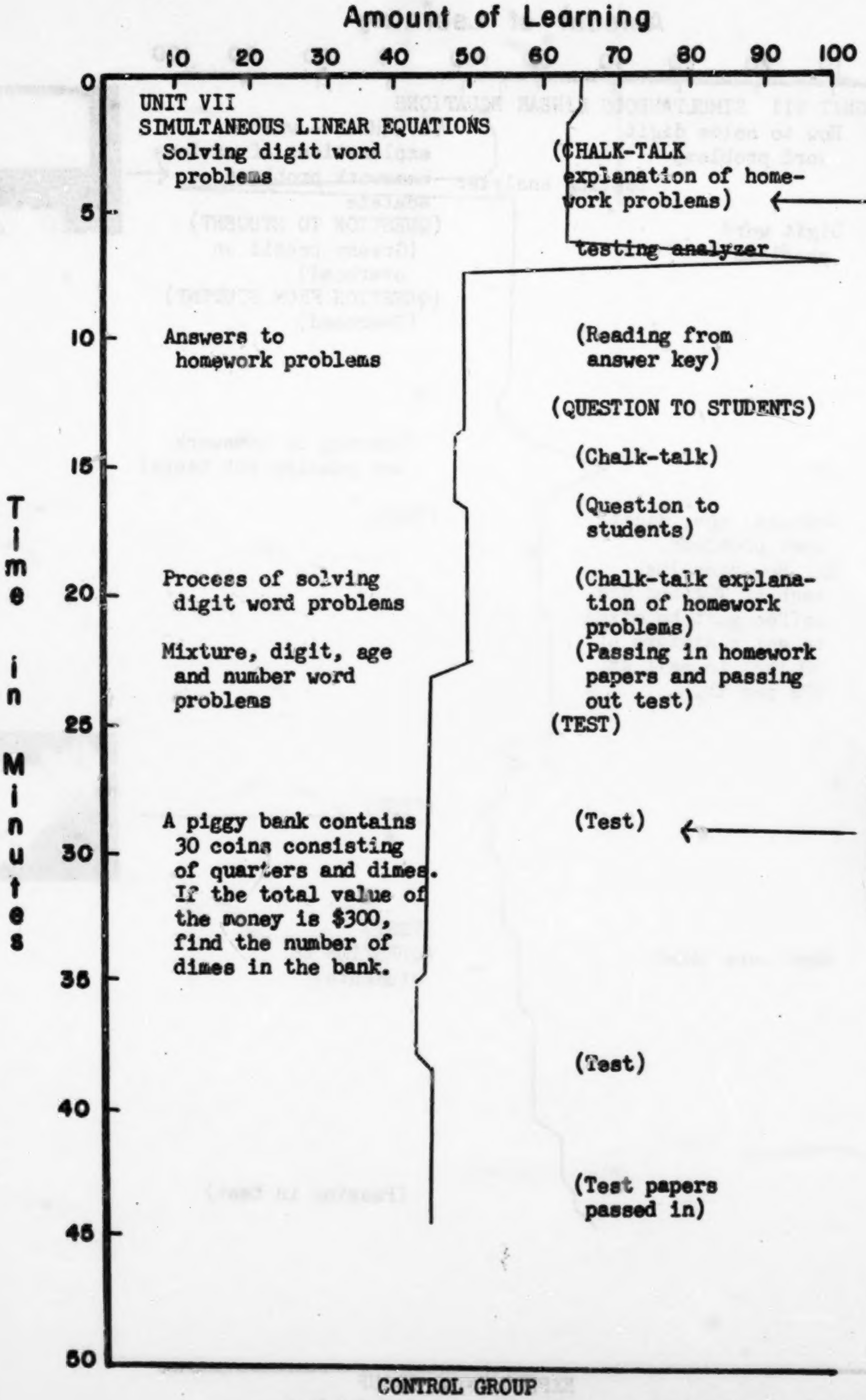

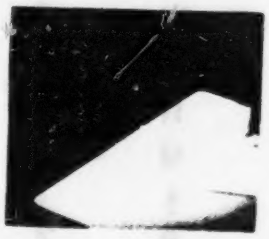

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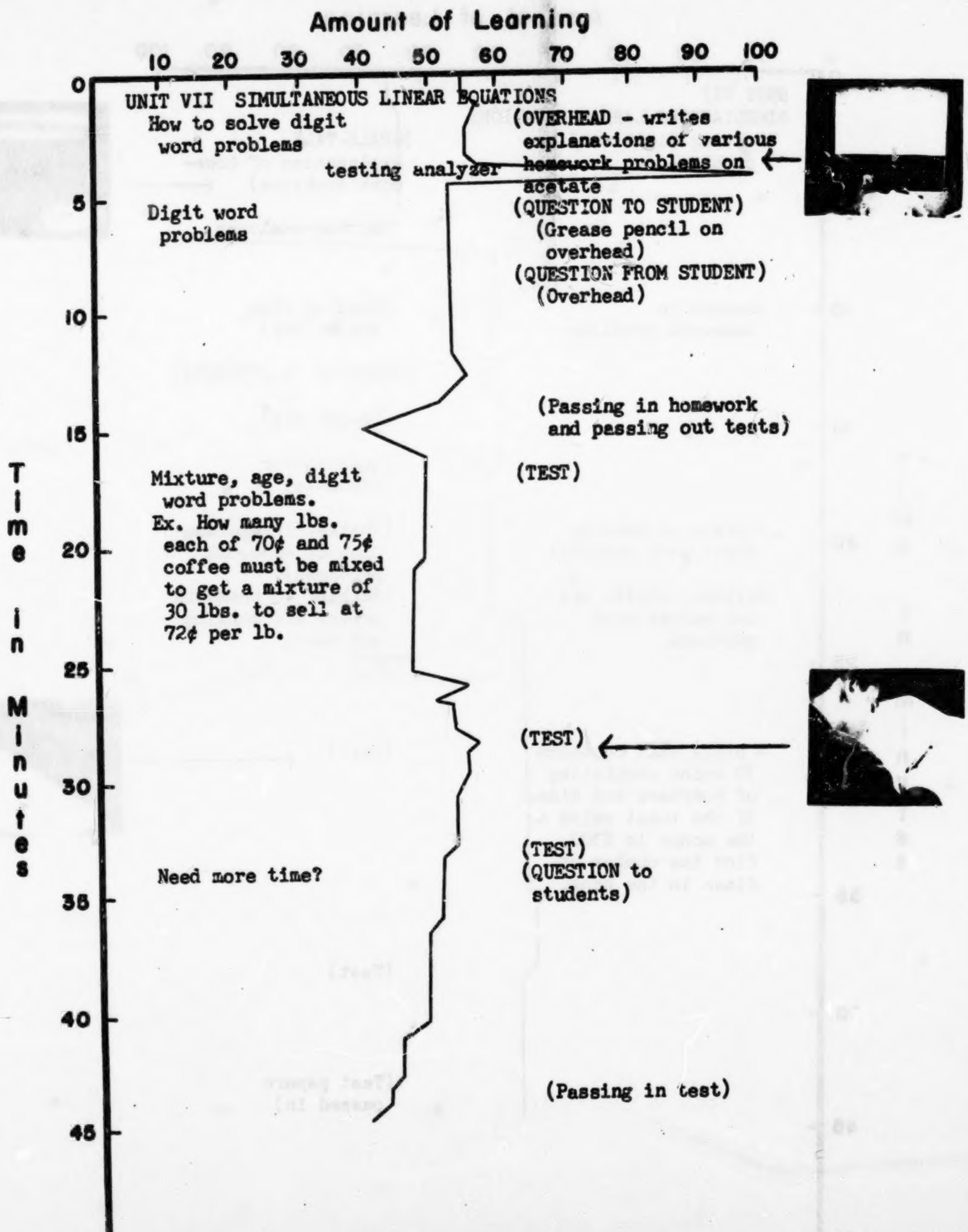

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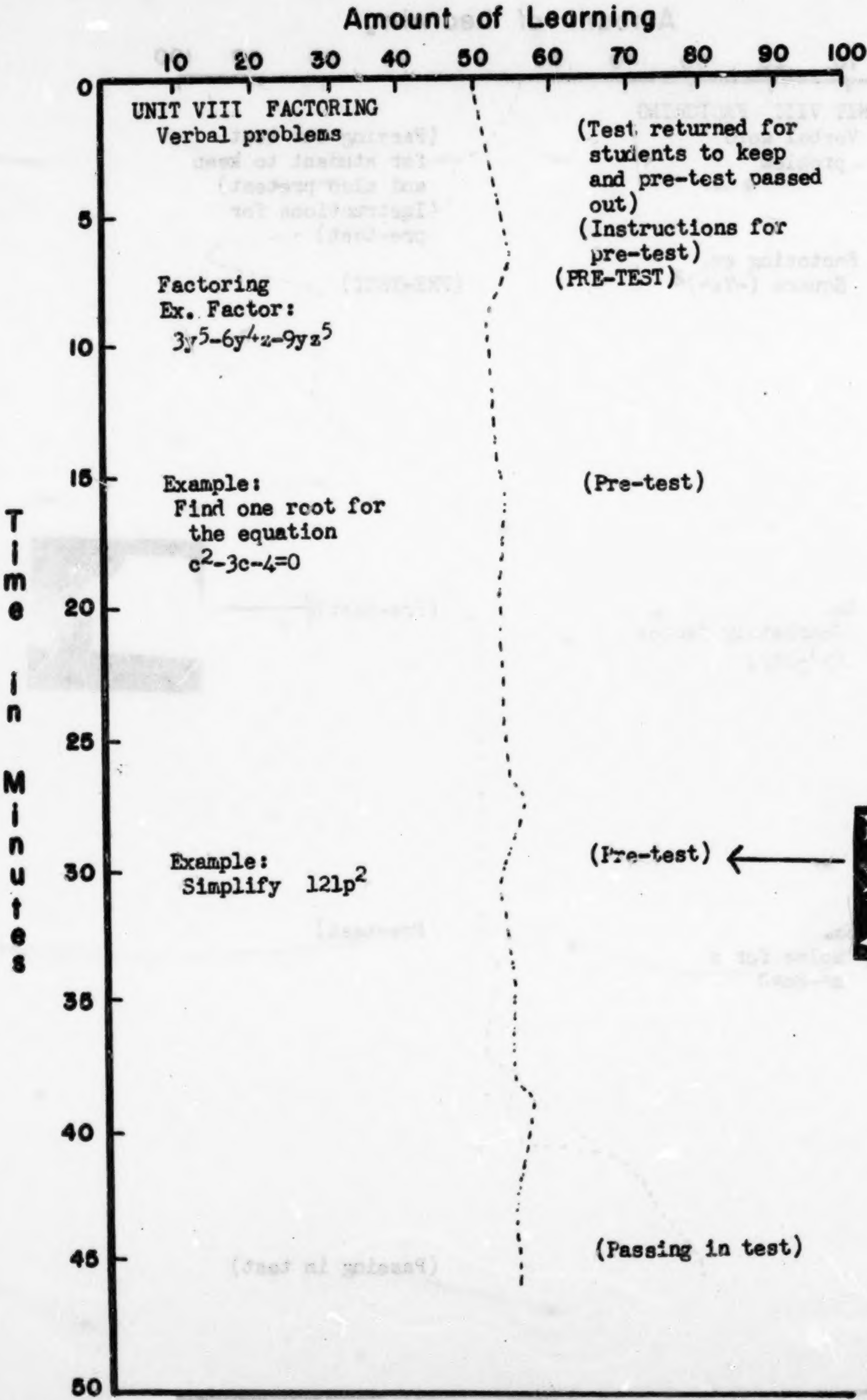

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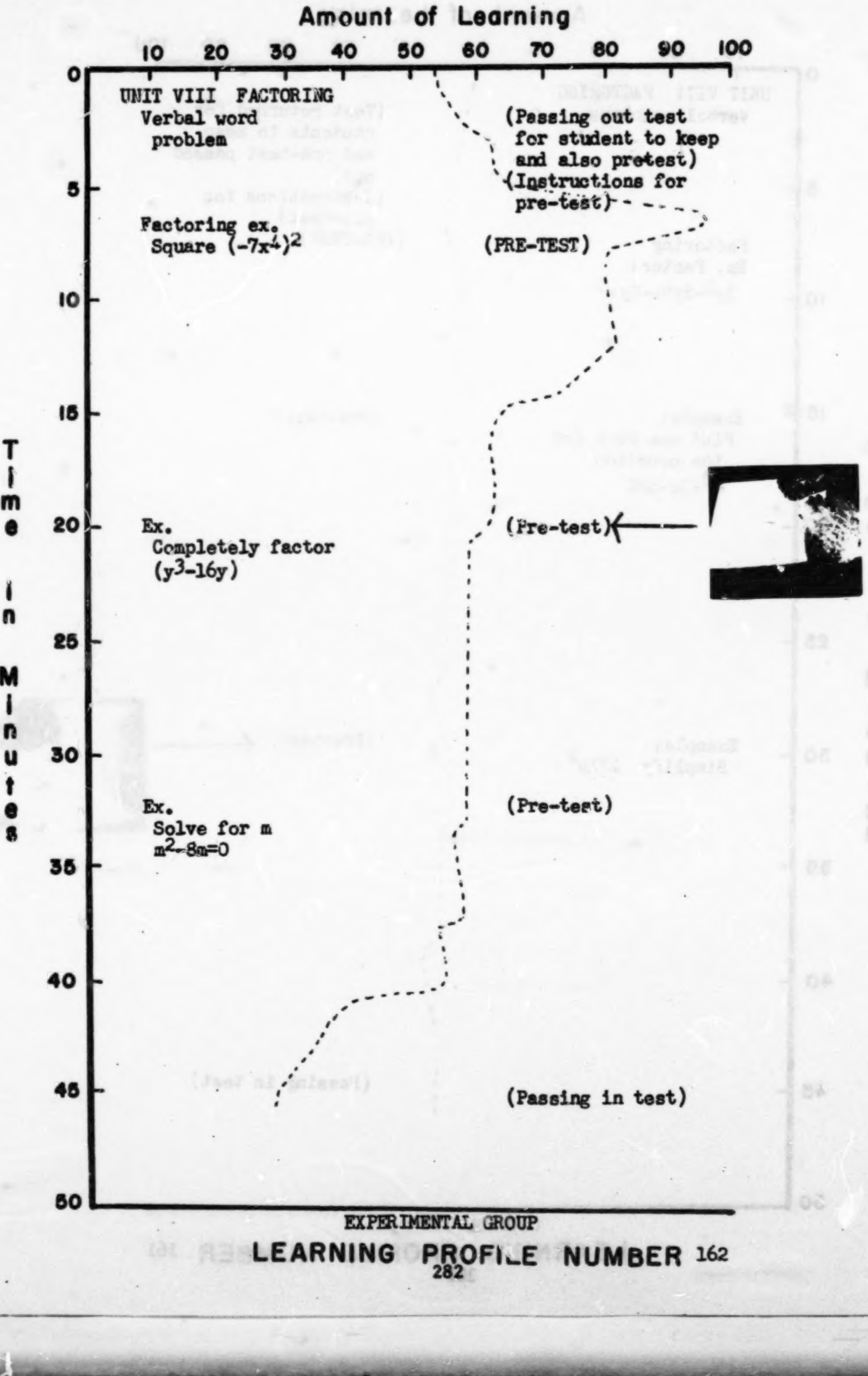

EXPERIMENTAL GROUP

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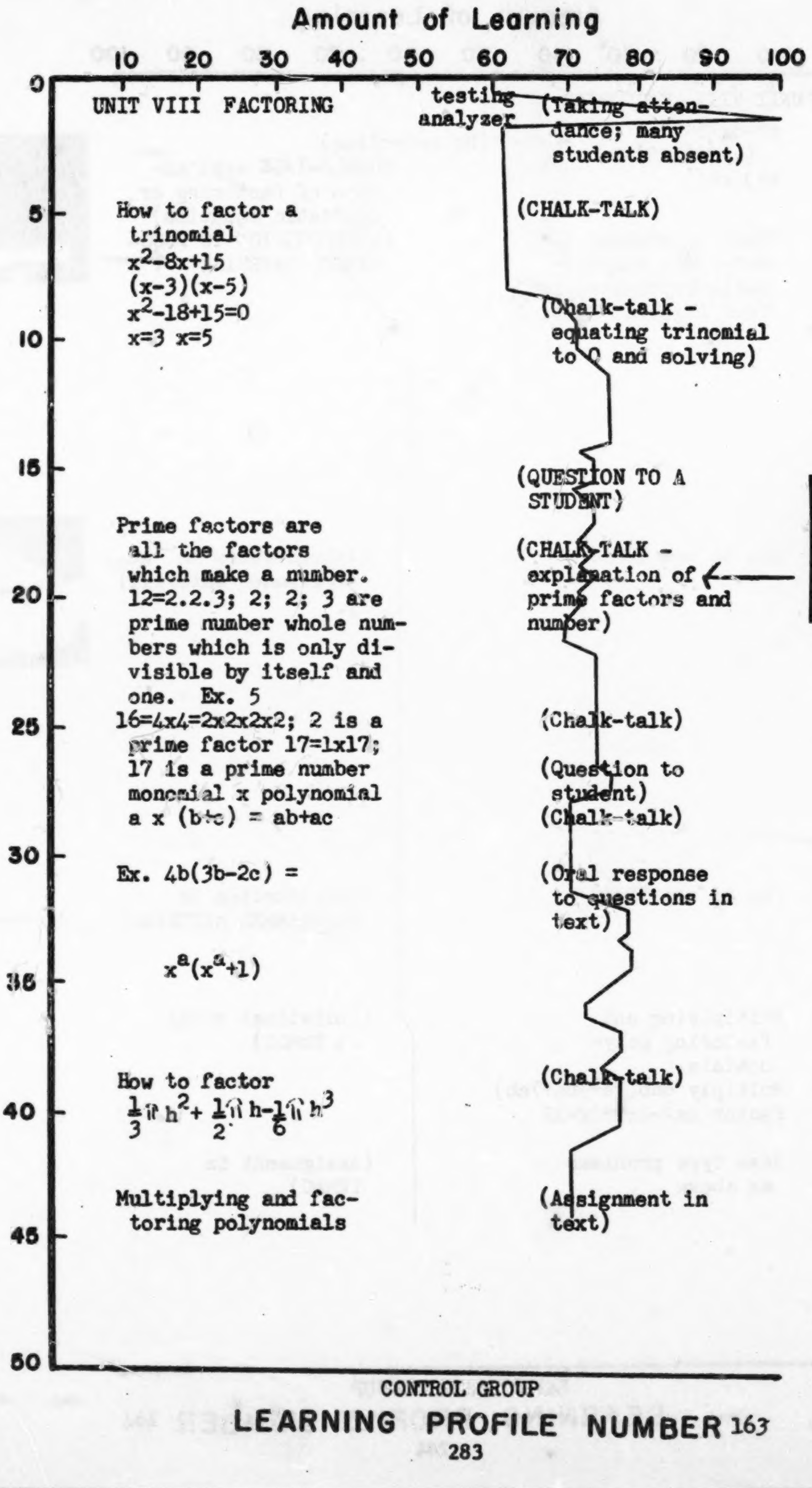


UNIT VIII FACTORING

(Taking attendance; many students absent)

How to factor a trinomial
$x^2-8x+15$
$(x-3)(x-5)$
$x^2-18+15=0$
$x=3$ $x=5$

(CHALK-TALK)

(Chalk-talk - equating trinomial to 0 and solving)

(QUESTION TO A STUDENT)

Prime factors are all the factors which make a number. 12=2.2.3; 2; 2; 3 are prime number whole numbers which is only divisible by itself and one. Ex. 5
16=4x4=2x2x2x2; 2 is a prime factor 17=1x17; 17 is a prime number
monomial x polynomial
$a \times (b+c) = ab+ac$

(CHALK-TALK - explanation of prime factors and number)

(Chalk-talk)

(Question to student)

(Chalk-talk)

Ex. $4b(3b-2c) =$

(Oral response to questions in text)

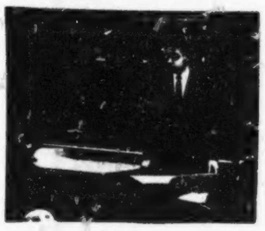
$x^a(x^a+1)$

How to factor
$\frac{1}{3}\pi h^2+\frac{1}{2}\pi h-\frac{1}{6}\pi h^3$

(Chalk-talk)

Multiplying and factoring polynomials

(Assignment in text)



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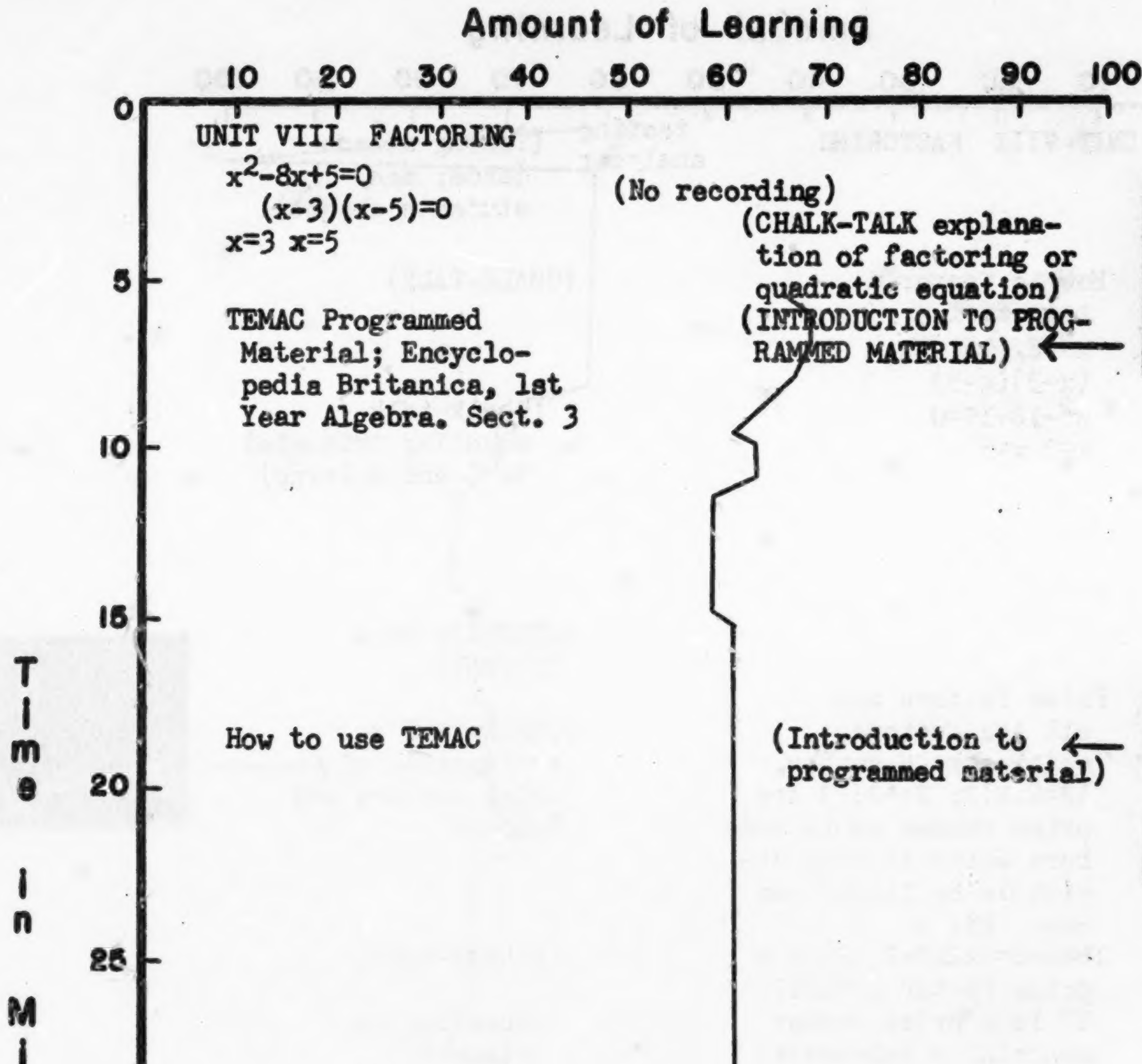
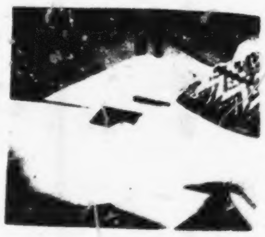
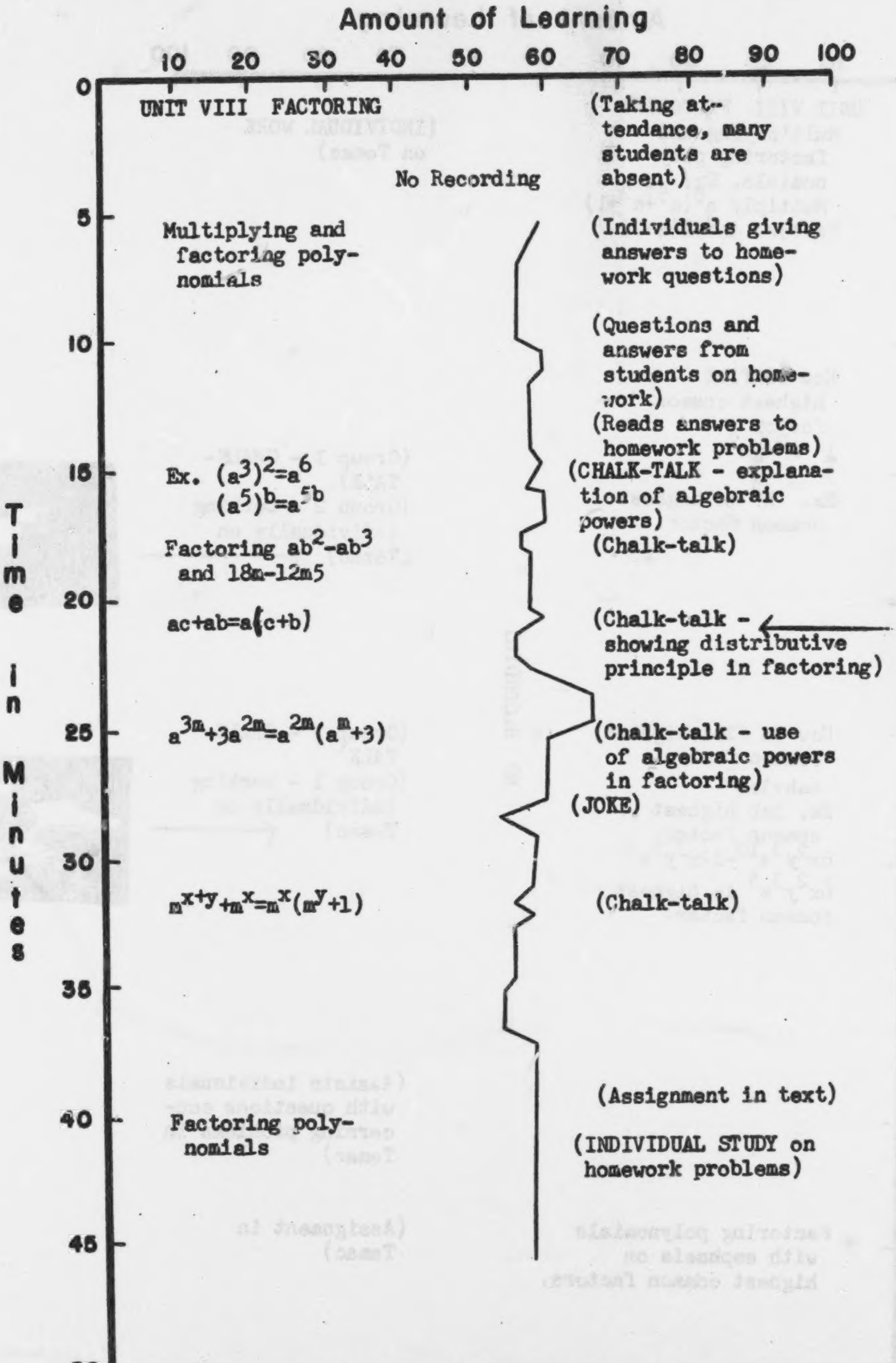




EXPERIMENTAL GROUP

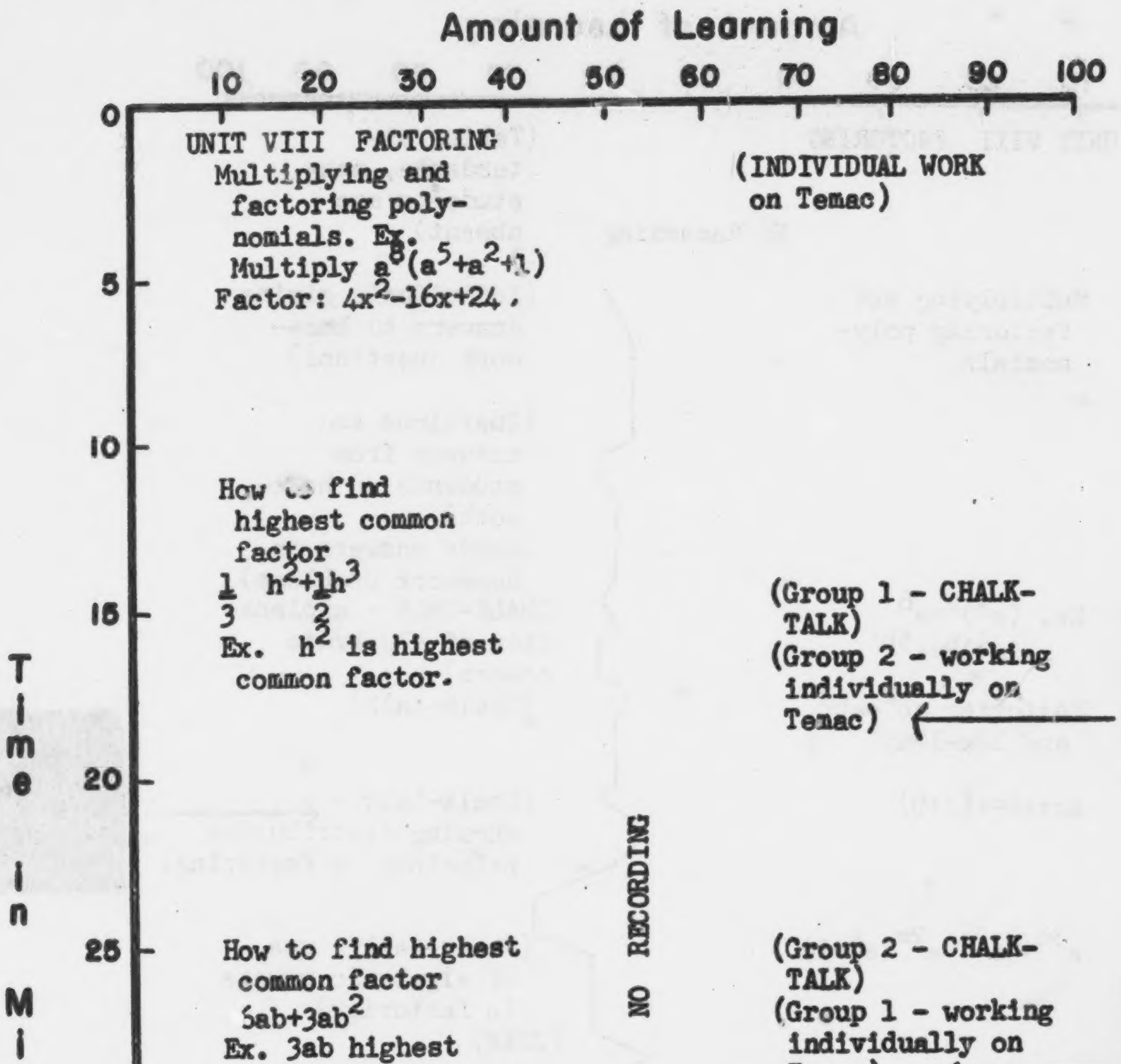
LEARNING PROFILE NUMBER 164



CONTROL GROUP

LEARNING PROFILE NUMBER 165

Group 1 (7 students)
Group 2 (11 students)

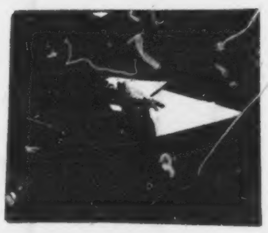


UNIT VIII FACTORING
Multiplying and factoring polynomials. Ex.
Multiply $a^8(a^5+a^2+1)$
Factor: $4x^2-16x+24$.

(INDIVIDUAL WORK on Temac)

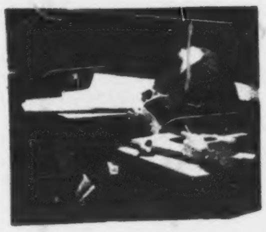
How to find highest common factor
$\frac{1}{3}h^2+\frac{1}{2}h^3$
Ex. h^2 is highest common factor.

(Group 1 - CHALK-TALK)
(Group 2 - working individually on Temac)



How to find highest common factor
$6ab+3ab^2$
Ex. 3ab highest common factor
$6x^2y^3z^{10}-12x^3y^5z^5$
$6x^2y^3z^5$ is highest common factor.

(Group 2 - CHALK-TALK)
(Group 1 - working individually on Temac)

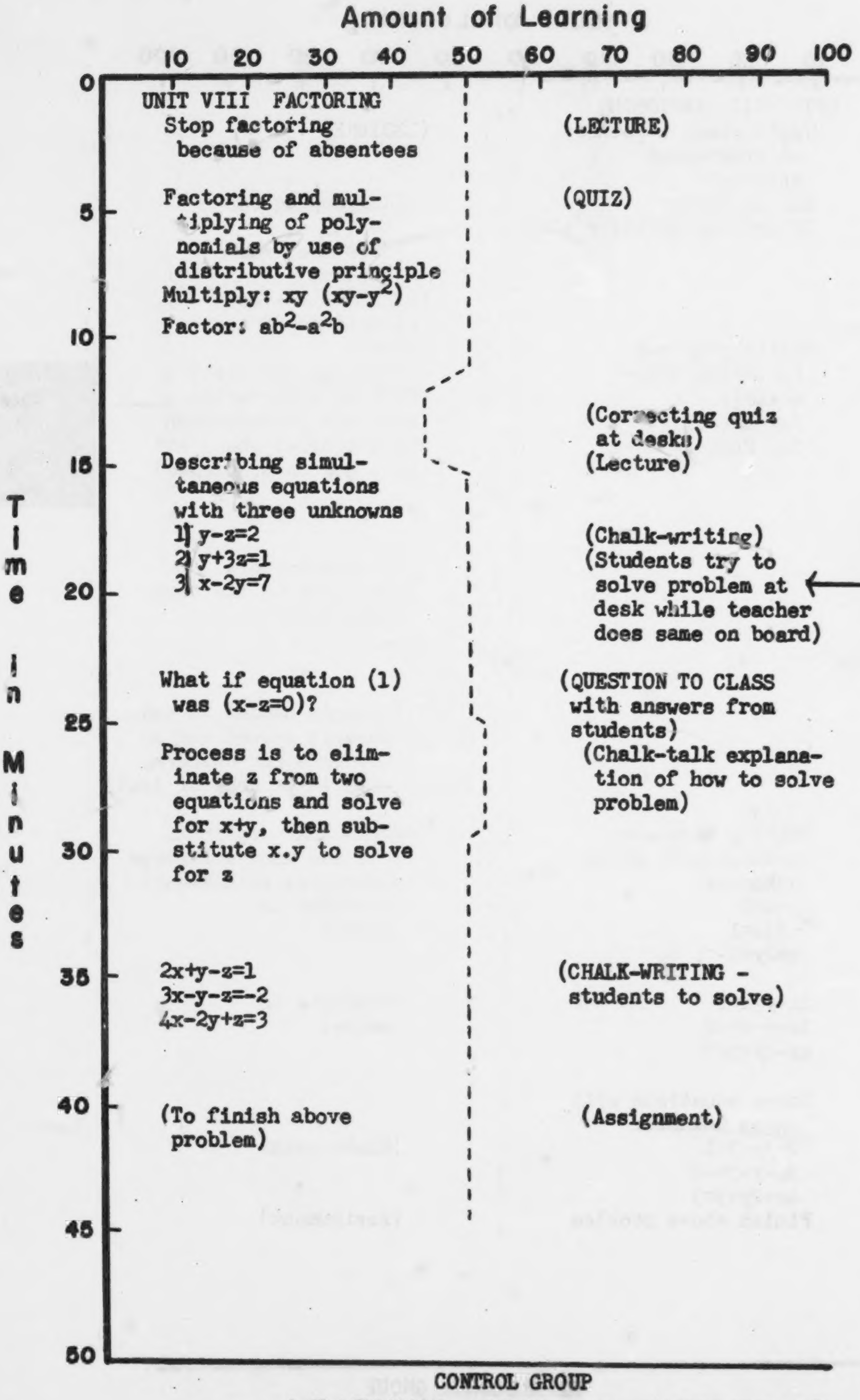


(Assists indivisuals with questions concerning problems in Temac)

Factoring polynomials with emphasis on highest common factors,

(Assignment in Temac)

EXPERIMENTAL GROUP
LEARNING PROFILE NUMBER 166



UNIT VIII FACTORING

Stop factoring because of absentees — (LECTURE)

Factoring and multiplying of polynomials by use of distributive principle — (QUIZ)

Multiply: xy $(xy-y^2)$

Factor: ab^2-a^2b

(Correcting quiz at desks)

Describing simultaneous equations with three unknowns — (Lecture)

1) $y-z=2$

2) $y+3z=1$

3) $x-2y=7$

(Chalk-writing)

(Students try to solve problem at desk while teacher does same on board)

What if equation (1) was $(x-z=0)$? — (QUESTION TO CLASS with answers from students)

Process is to eliminate z from two equations and solve for x+y, then substitute x.y to solve for z — (Chalk-talk explanation of how to solve problem)

$2x+y-z=1$

$3x-y-z=-2$

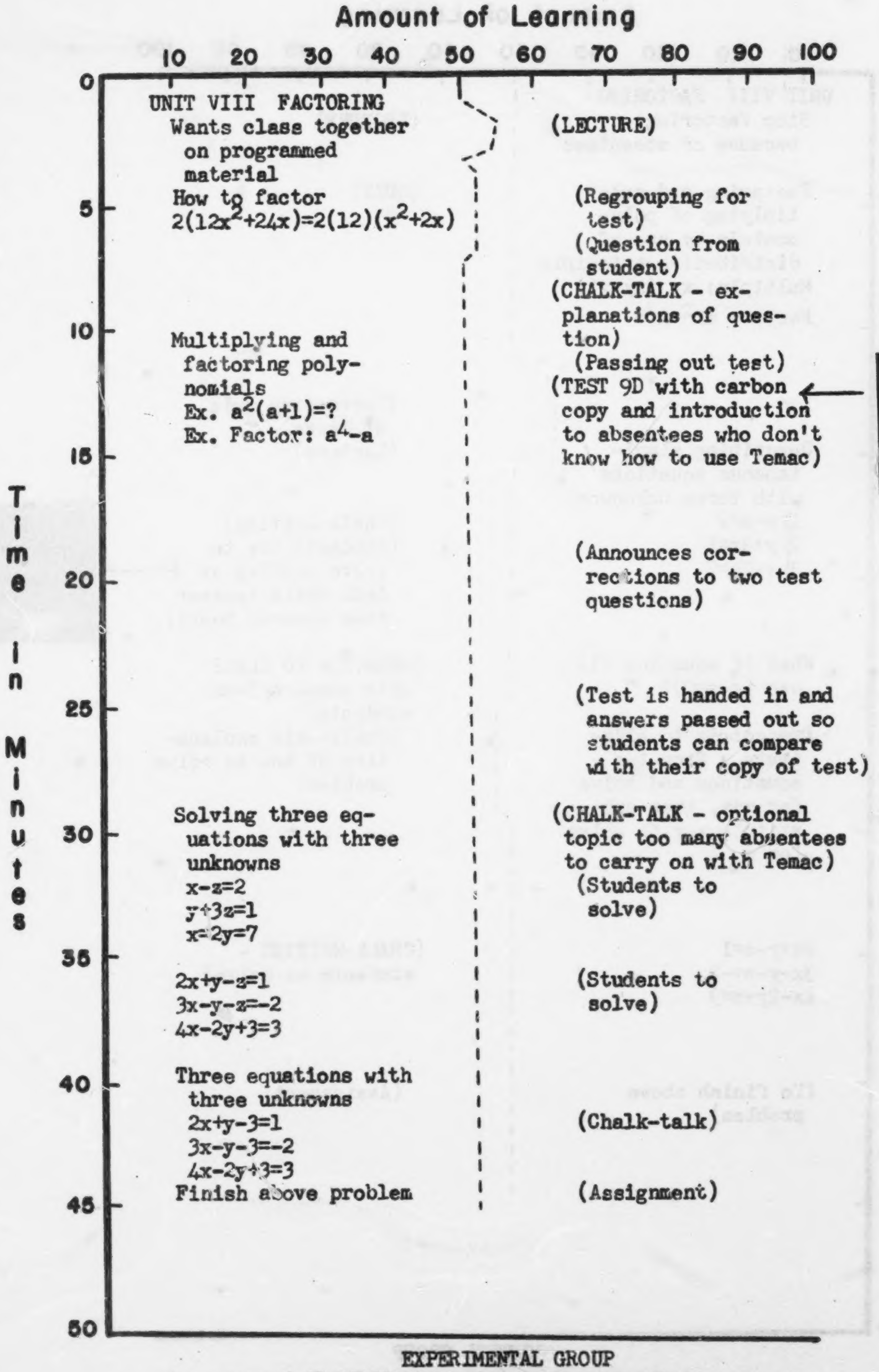
$4x-2y+z=3$

(CHALK-WRITING - students to solve)

(To finish above problem) — (Assignment)

CONTROL GROUP

LEARNING PROFILE NUMBER 167



UNIT VIII FACTORING

Wants class together on programmed material

How to factor $2(12x^2+24x)=2(12)(x^2+2x)$

Multiplying and factoring polynomials

Ex. $a^2(a+1)=?$

Ex. Factor: a^4-a

Solving three equations with three unknowns

$x-z=2$

$y+3z=1$

$x-2y=7$

$2x+y-z=1$

$3x-y-z=-2$

$4x-2y+3=3$

Three equations with three unknowns

$2x+y-3=1$

$3x-y-3=-2$

$4x-2y+3=3$

Finish above problem

(LECTURE)

(Regrouping for test)

(Question from student)

(CHALK-TALK - explanations of question)

(Passing out test)

(TEST 9D with carbon copy and introduction to absentees who don't know how to use Temac) ←

(Announces corrections to two test questions)

(Test is handed in and answers passed out so students can compare with their copy of test)

(CHALK-TALK - optional topic too many absentees to carry on with Temac)

(Students to solve)

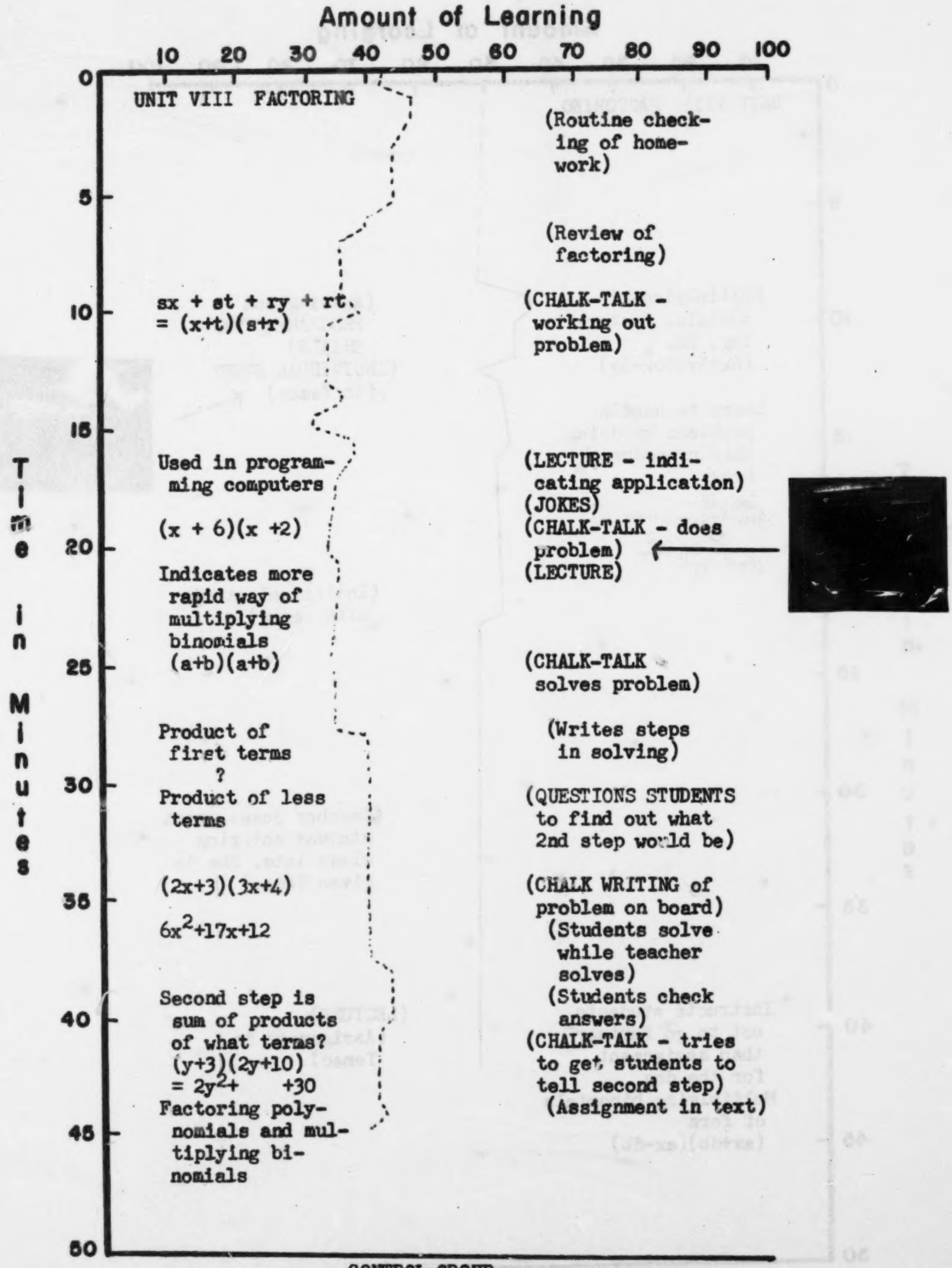
(Students to solve)

(Chalk-talk)

(Assignment)

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 168



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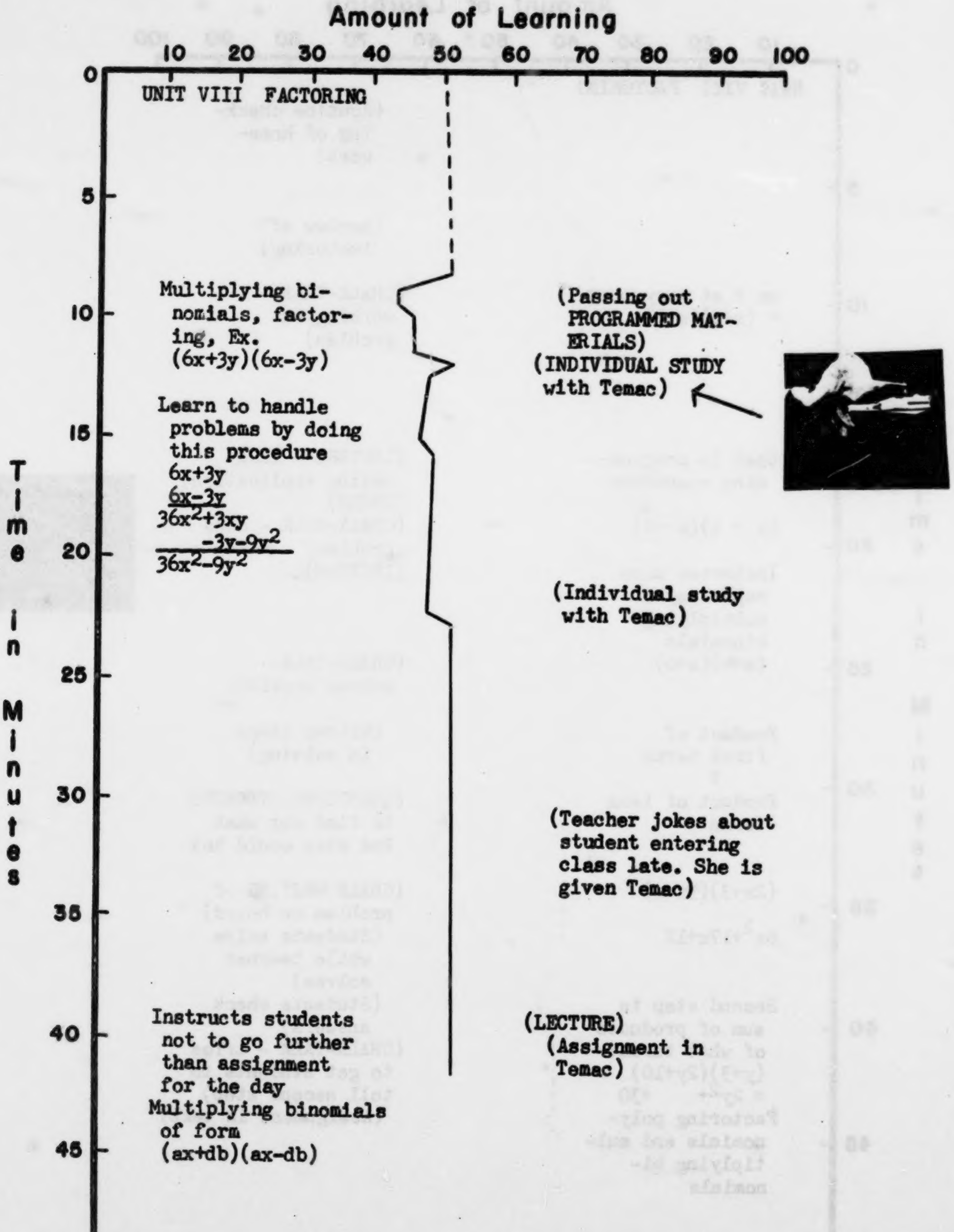

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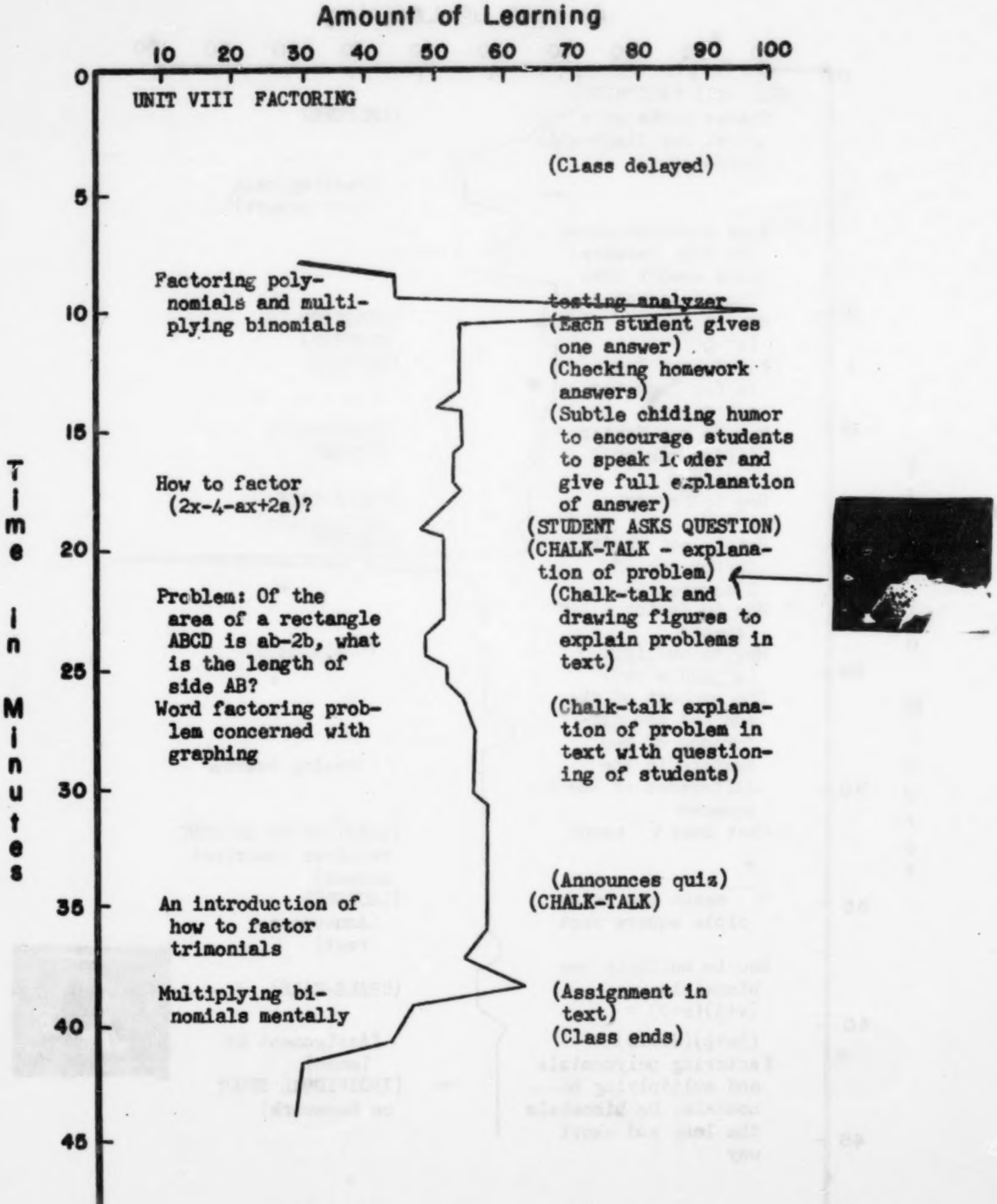

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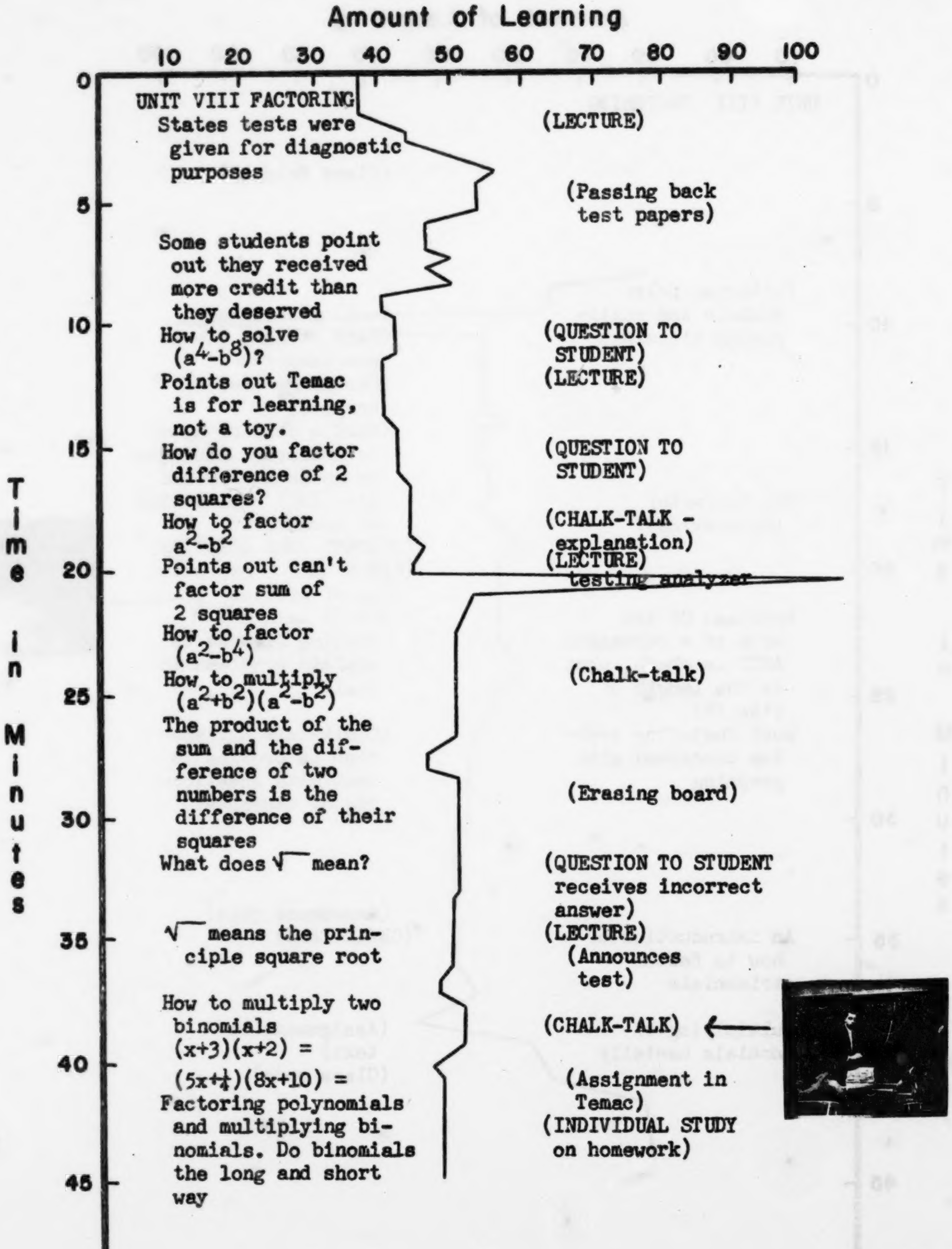

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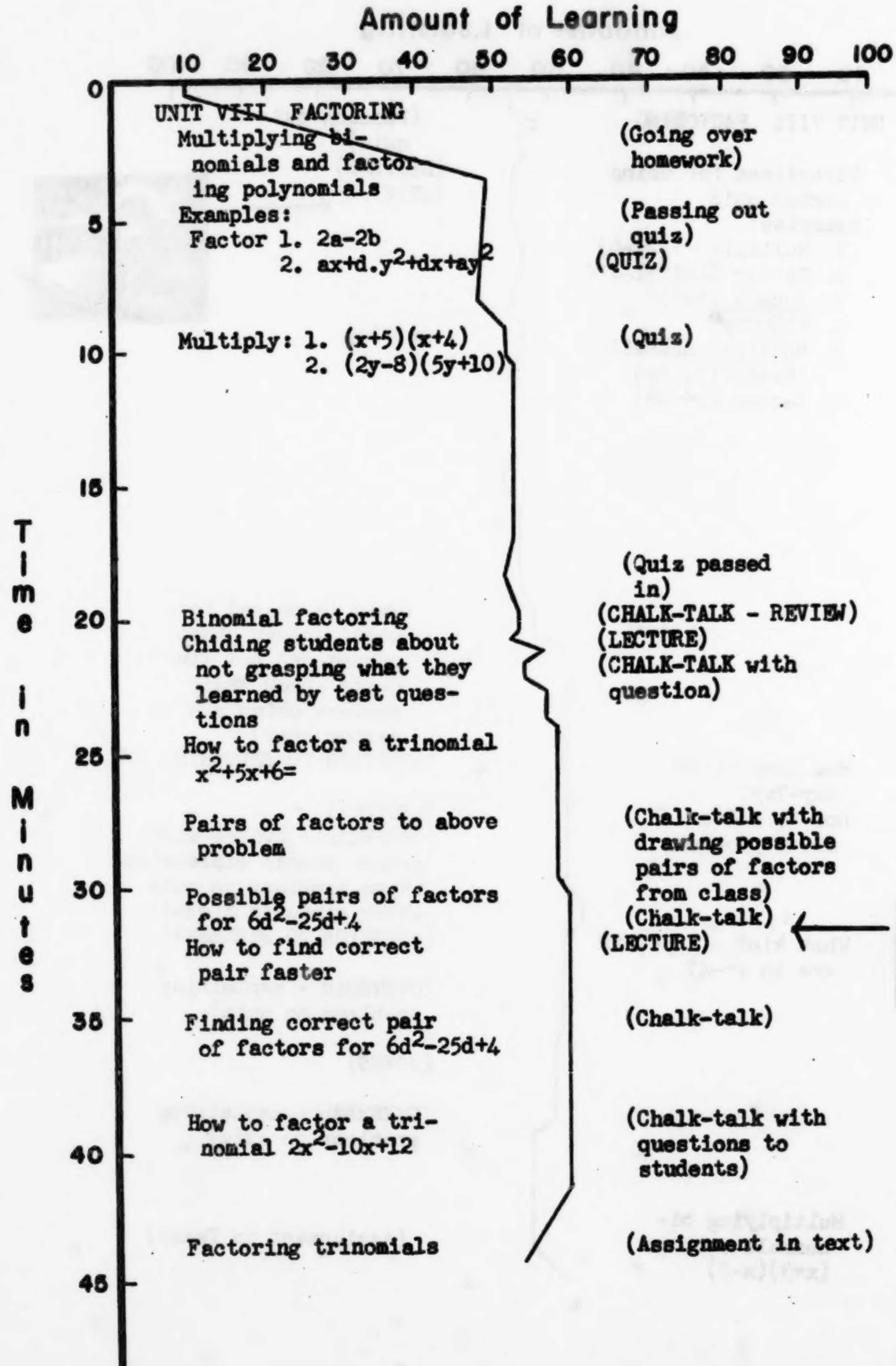

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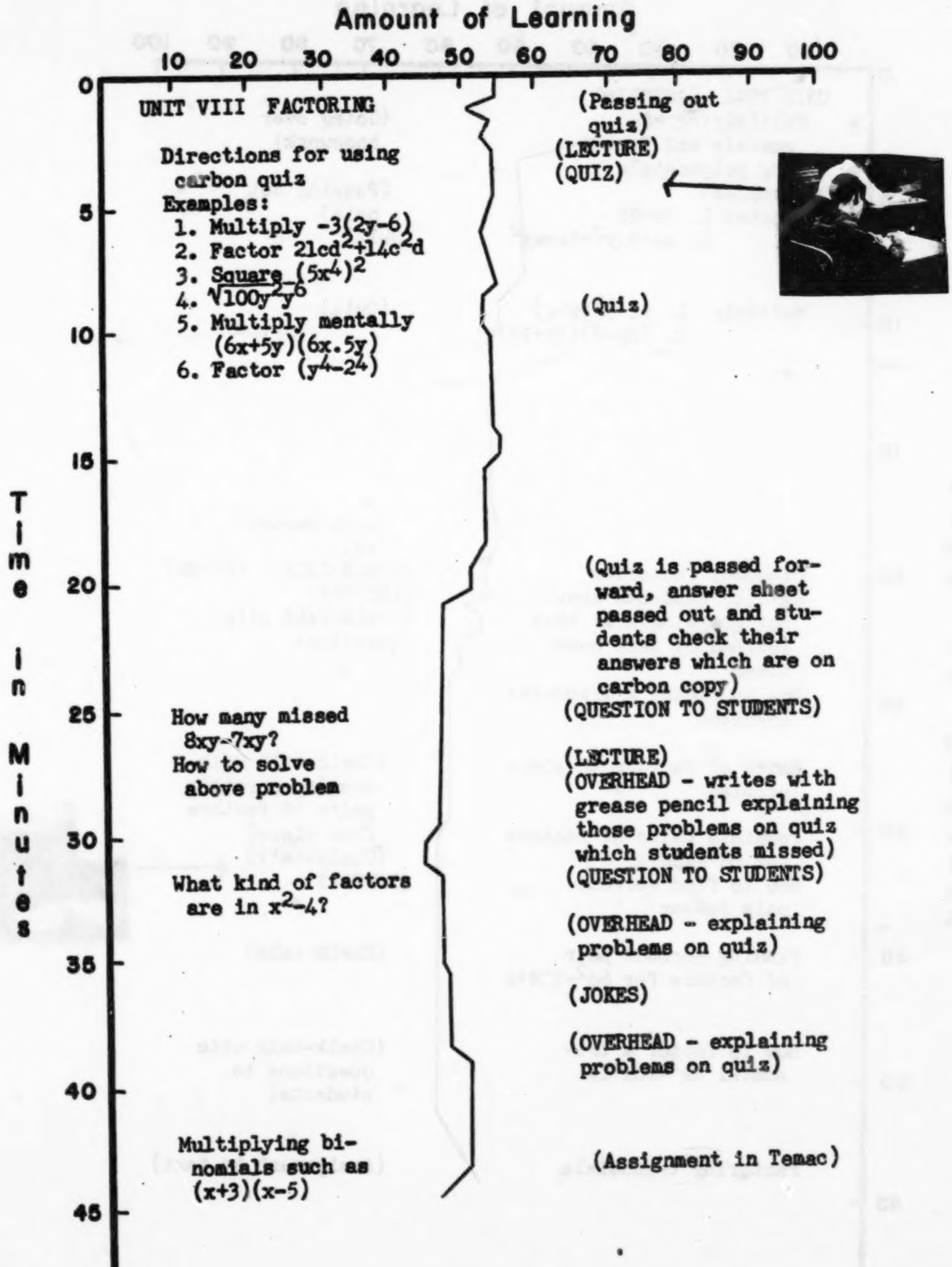

EXPERIMENTAL GROUP

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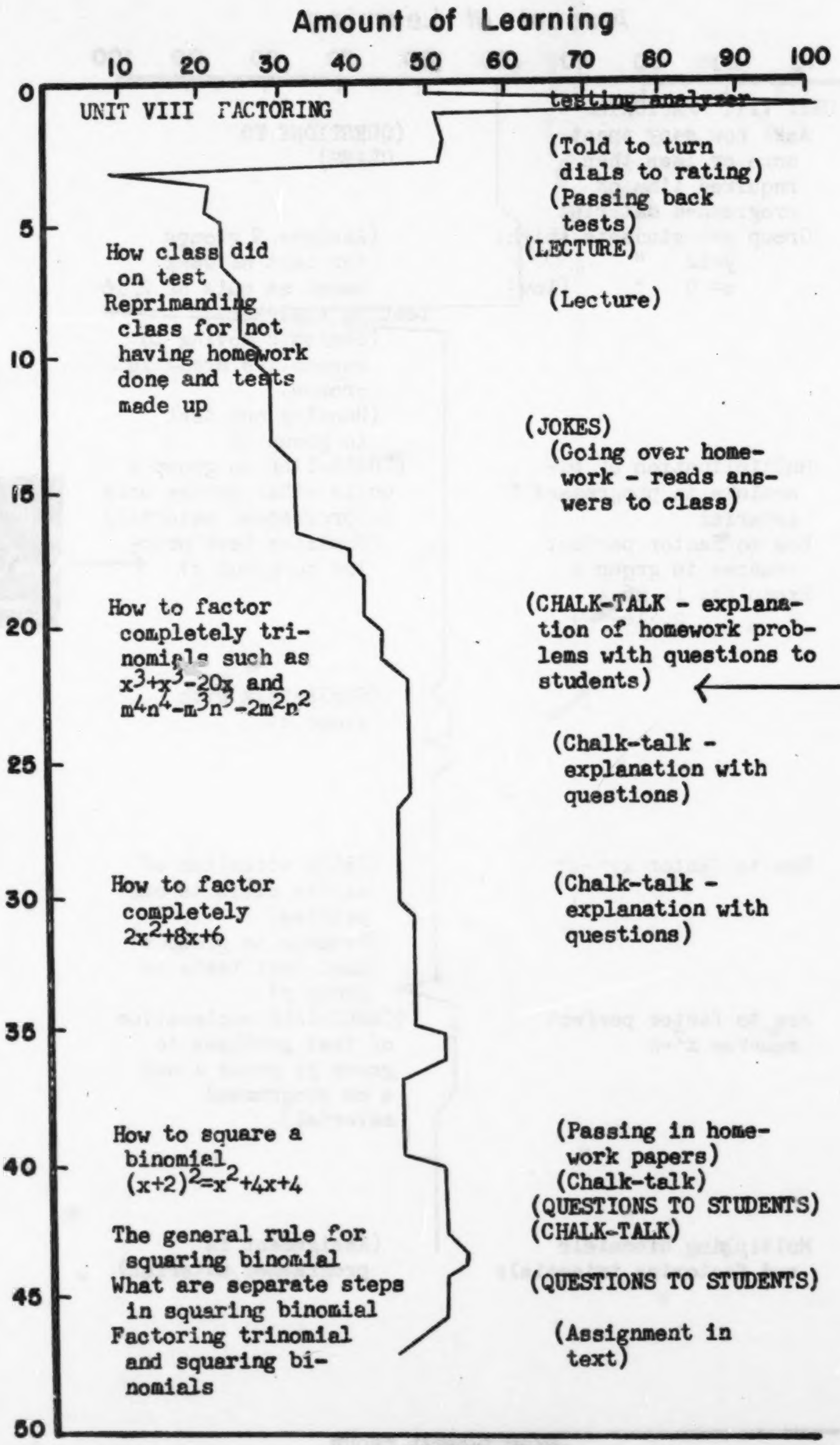


UNIT VIII FACTORING

testing analyser

(Told to turn dials to rating)

(Passing back tests)

(LECTURE)

How class did on test

Reprimanding class for not having homework done and tests made up

(Lecture)

(JOKES)

(Going over homework - reads answers to class)

How to factor completely trinomials such as x^3+x^3-20x and $m^4n^4-m^3n^3-2m^2n^2$

(CHALK-TALK - explanation of homework problems with questions to students)

(Chalk-talk - explanation with questions)

How to factor completely $2x^2+8x+6$

(Chalk-talk - explanation with questions)

How to square a binomial $(x+2)^2=x^2+4x+4$

(Passing in homework papers)

(Chalk-talk)

(QUESTIONS TO STUDENTS)

(CHALK-TALK)

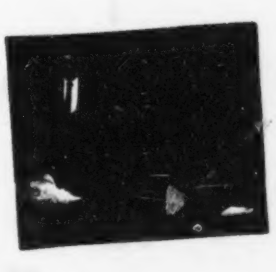
The general rule for squaring binomial

What are separate steps in squaring binomial

(QUESTIONS TO STUDENTS)

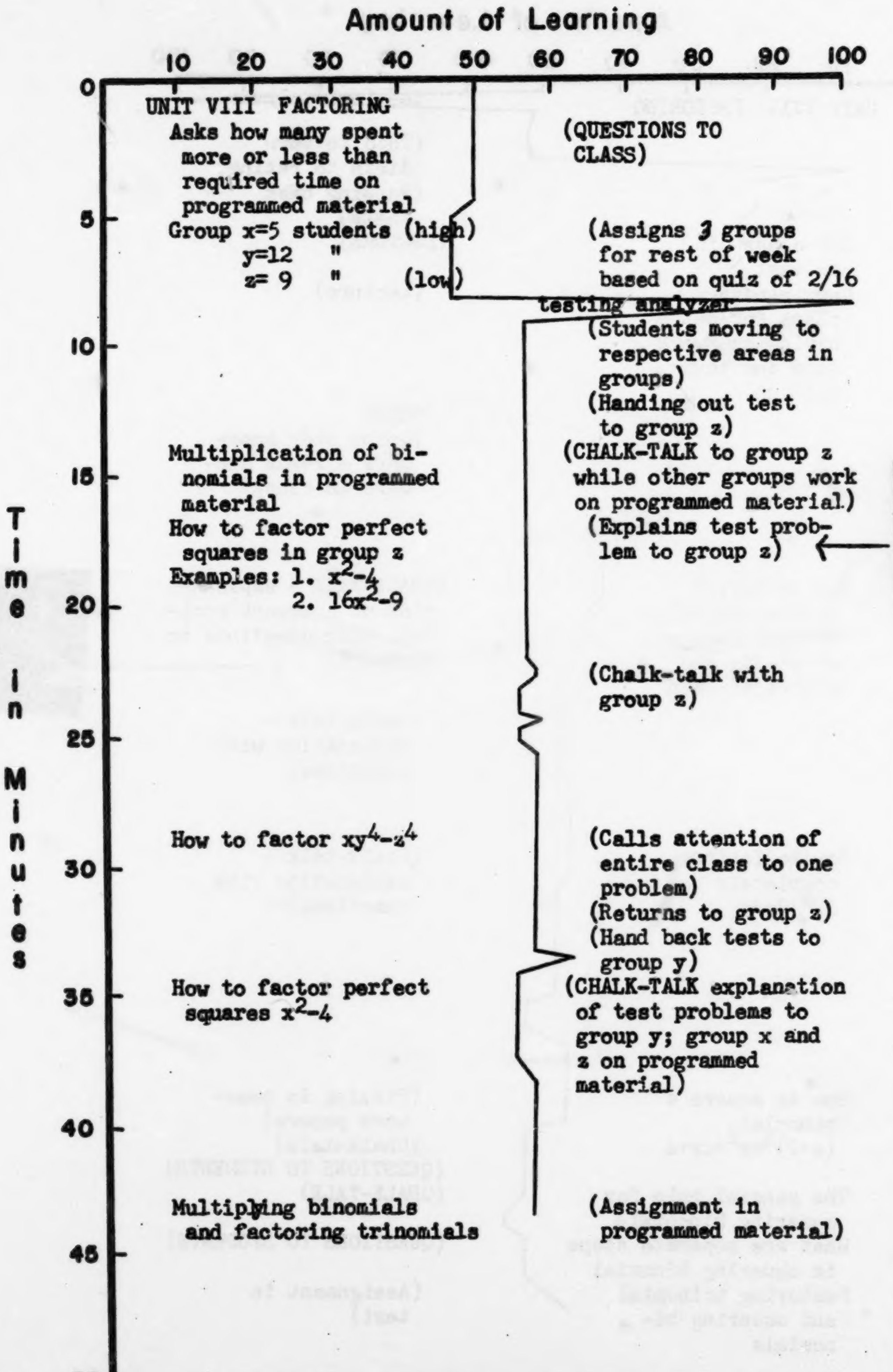
Factoring trinomial and squaring binomials

(Assignment in text)



CONTROL GROUP

LEARNING PROFILE NUMBER 175



UNIT VIII FACTORING

Asks how many spent more or less than required time on programmed material

(QUESTIONS TO CLASS)

Group x=5 students (high)
y=12 "
z= 9 " (low)

(Assigns 3 groups for rest of week based on quiz of 2/16

testing analyzer

(Students moving to respective areas in groups)

(Handing out test to group z)

Multiplication of binomials in programmed material

(CHALK-TALK to group z while other groups work on programmed material.)

How to factor perfect squares in group z

Examples: 1. x^2-4
2. $16x^2-9$

(Explains test problem to group z)

(Chalk-talk with group z)

How to factor xy^4-z^4

(Calls attention of entire class to one problem)

(Returns to group z)

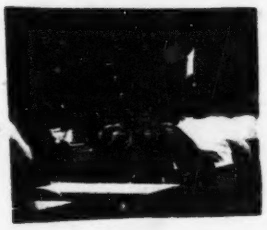
(Hand back tests to group y)

How to factor perfect squares x^2-4

(CHALK-TALK explanation of test problems to group y; group x and z on programmed material)

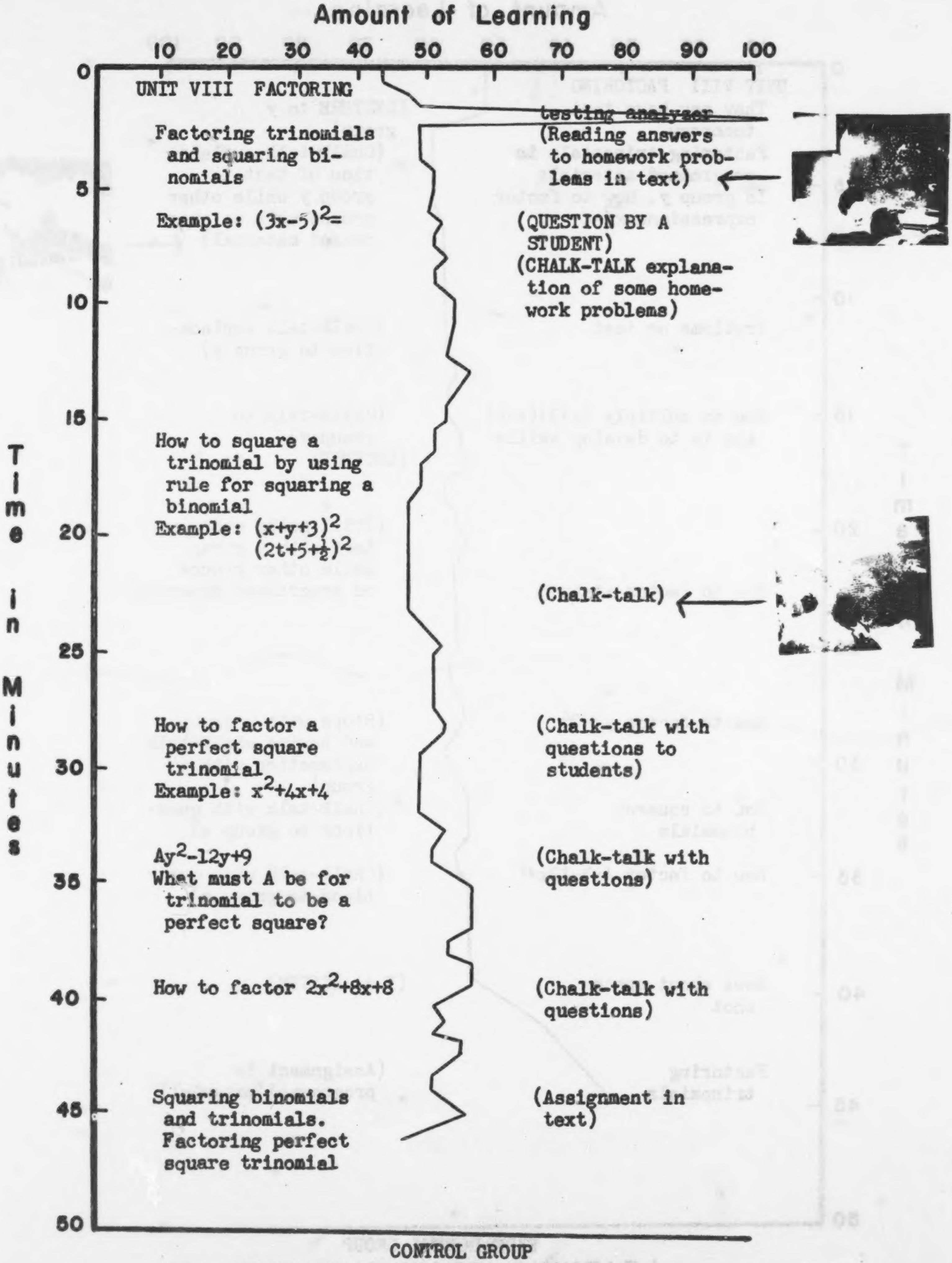
Multiplying binomials and factoring trinomials

(Assignment in programmed material)



EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 176



UNIT VIII FACTORING

Factoring trinomials and squaring binomials

Example: $(3x-5)^2=$

~~testing analyser~~
(Reading answers to homework problems in text)

(QUESTION BY A STUDENT)

(CHALK-TALK explanation of some homework problems)

How to square a trinomial by using rule for squaring a binomial

Example: $(x+y+3)^2$
$(2t+5+\frac{1}{2})^2$

(Chalk-talk)

How to factor a perfect square trinomial

Example: x^2+4x+4

(Chalk-talk with questions to students)

$Ay^2-12y+9$

What must A be for trinomial to be a perfect square?

(Chalk-talk with questions)

How to factor $2x^2+8x+8$

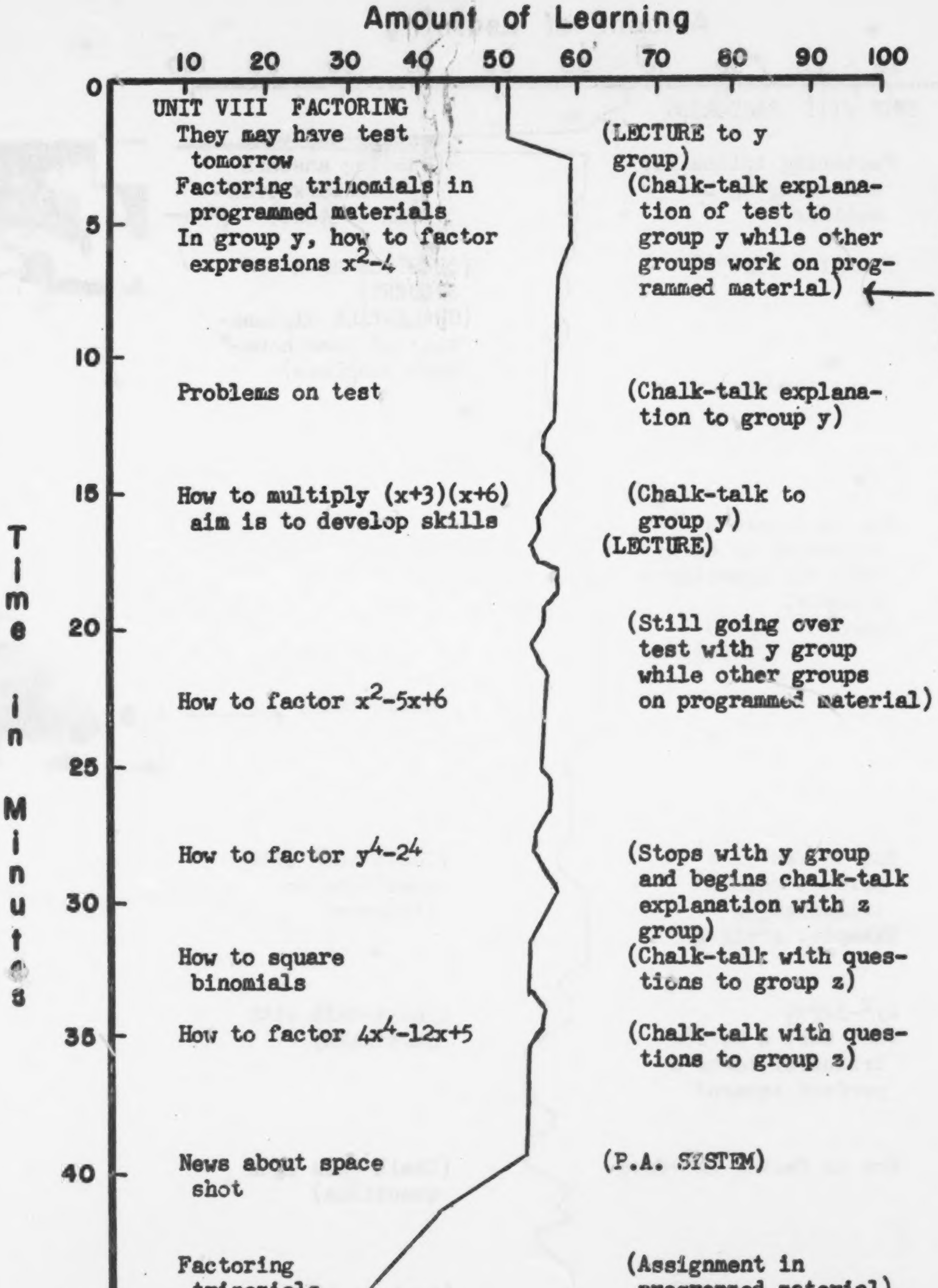
(Chalk-talk with questions)

Squaring binomials and trinomials. Factoring perfect square trinomial

(Assignment in text)

CONTROL GROUP

LEARNING PROFILE NUMBER 177



UNIT VIII FACTORING

They may have test tomorrow — (LECTURE to y group)

Factoring trinomials in programmed materials — (Chalk-talk explanation of test to group y while other groups work on programmed material)

In group y, how to factor expressions x^2-4

Problems on test — (Chalk-talk explanation to group y)

How to multiply $(x+3)(x+6)$ aim is to develop skills — (Chalk-talk to group y) (LECTURE)

(Still going over test with y group while other groups on programmed material)

How to factor x^2-5x+6

How to factor y^4-2^4 — (Stops with y group and begins chalk-talk explanation with z group)

How to square binomials — (Chalk-talk with questions to group z)

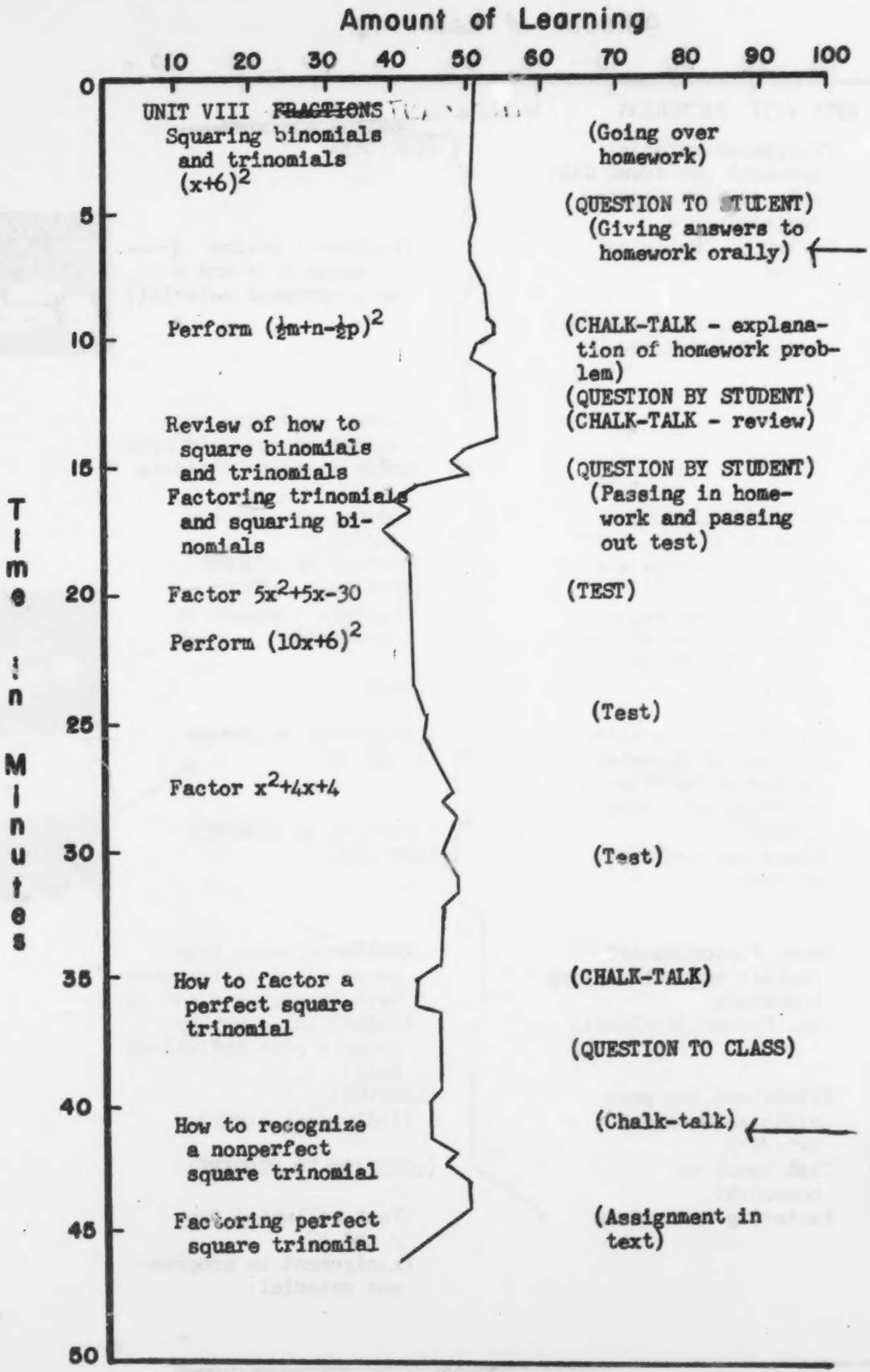
How to factor $4x^4-12x+5$ — (Chalk-talk with questions to group z)

News about space shot — (P.A. SYSTEM)

Factoring trinomials — (Assignment in programmed material)

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 178



CONTROL GROUP

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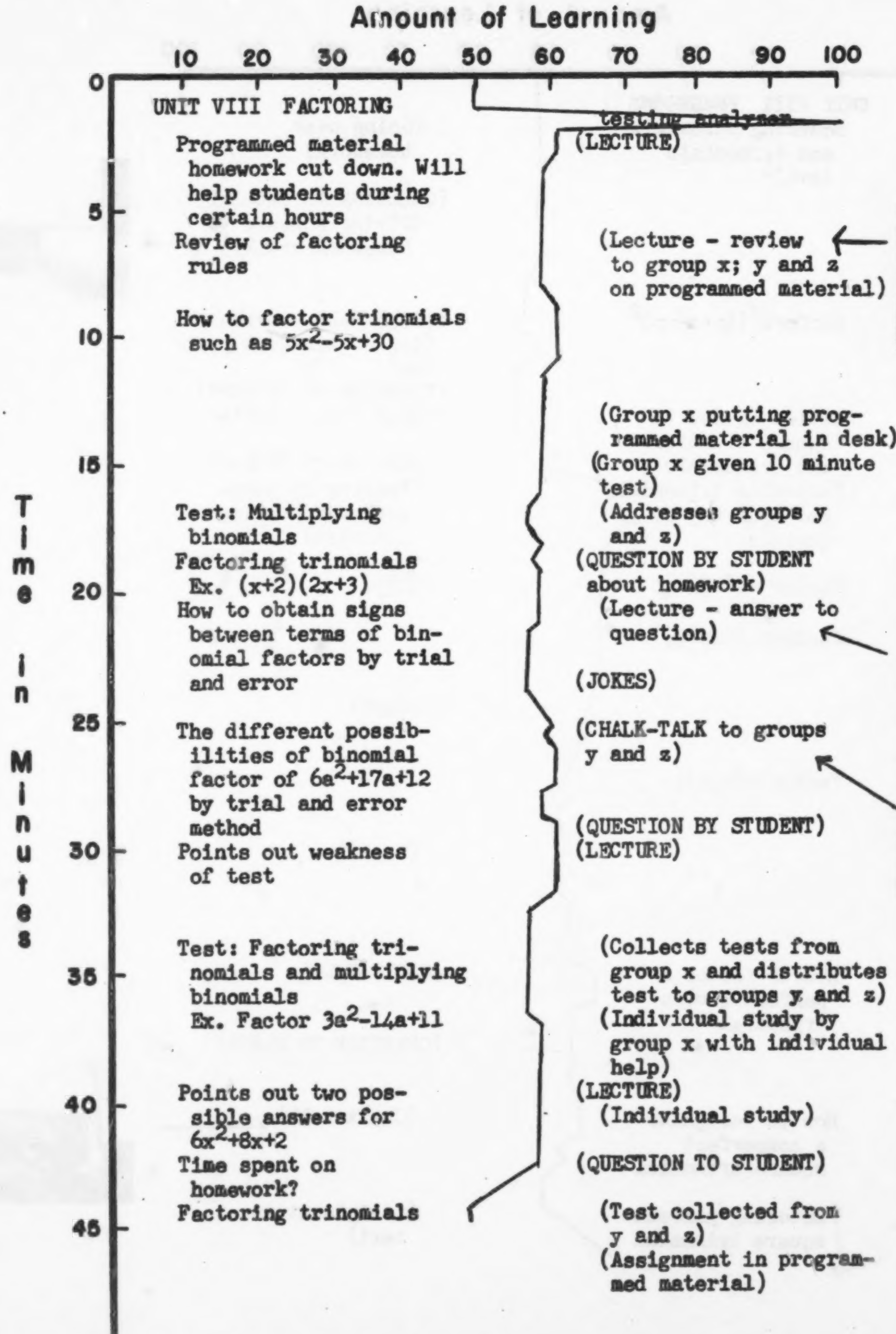


UNIT VIII FACTORING

Programmed material homework cut down. Will help students during certain hours

Review of factoring rules

How to factor trinomials such as $5x^2-5x+30$

Test: Multiplying binomials

Factoring trinomials Ex. $(x+2)(2x+3)$

How to obtain signs between terms of binomial factors by trial and error

The different possibilities of binomial factor of $6a^2+17a+12$ by trial and error method

Points out weakness of test

Test: Factoring trinomials and multiplying binomials Ex. Factor $3a^2-14a+11$

Points out two possible answers for $6x^2+8x+2$

Time spent on homework?

Factoring trinomials

testing analyses

(LECTURE)

(Lecture - review to group x; y and z on programmed material)

(Group x putting programmed material in desk)

(Group x given 10 minute test)

(Addresses groups y and z)

(QUESTION BY STUDENT about homework)

(Lecture - answer to question)

(JOKES)

(CHALK-TALK to groups y and z)

(QUESTION BY STUDENT)

(LECTURE)

(Collects tests from group x and distributes test to groups y and z)

(Individual study by group x with individual help)

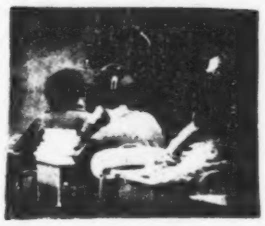
(LECTURE)

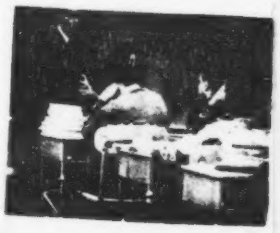
(Individual study)

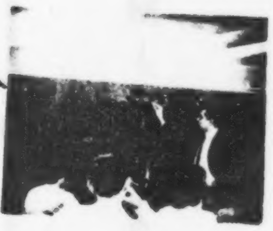
(QUESTION TO STUDENT)

(Test collected from y and z)

(Assignment in programmed material)







EXPERIMENTAL GROUP

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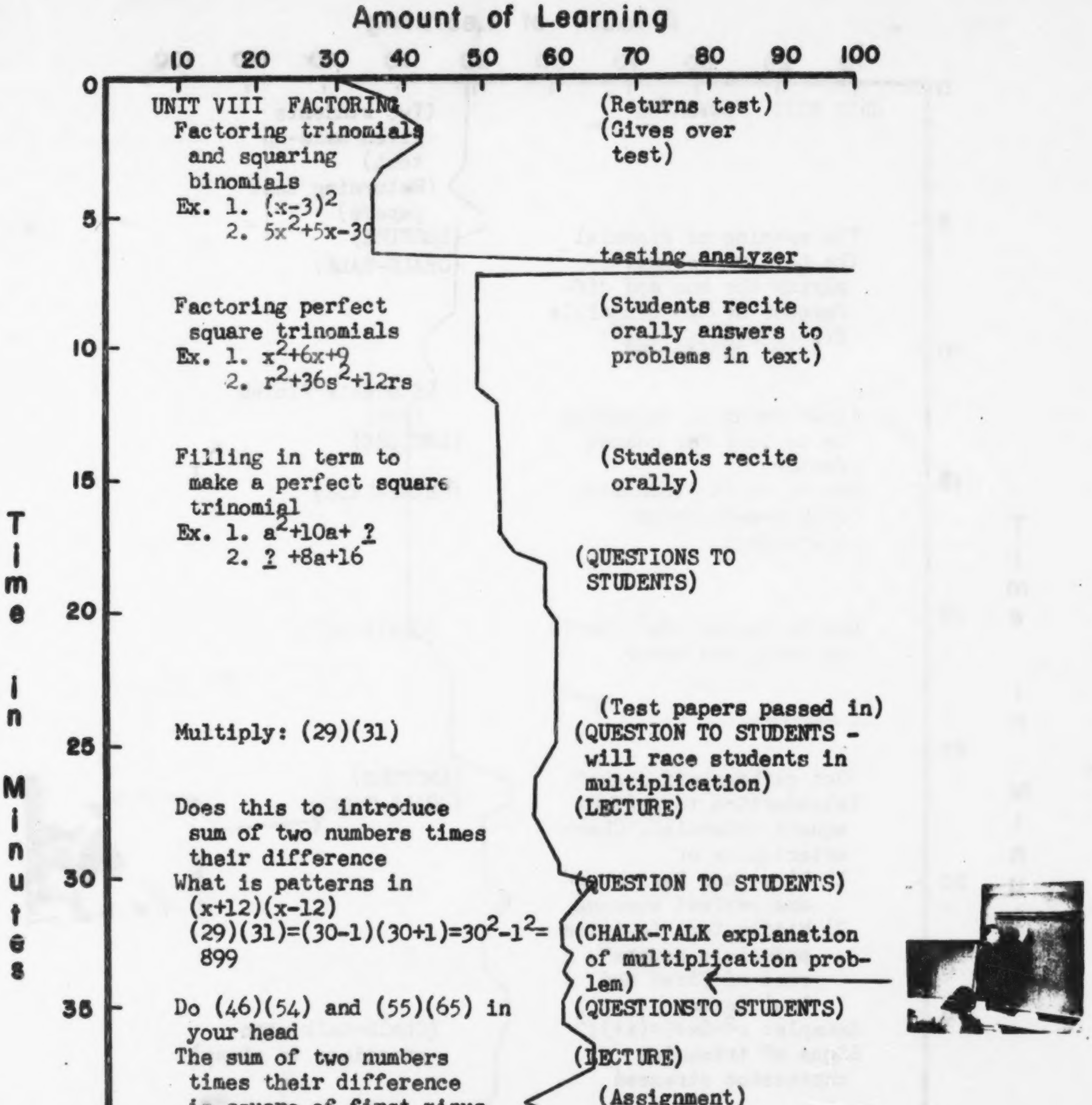

UNIT VIII FACTORING

Factoring trinomials and squaring binomials

Ex. 1. $(x-3)^2$

2. $5x^2+5x-30$

(Returns test)

(Gives over test)

testing analyzer

Factoring perfect square trinomials

Ex. 1. x^2+6x+9

2. r^2+36s^2+12rs

(Students recite orally answers to problems in text)

Filling in term to make a perfect square trinomial

Ex. 1. $a^2+10a+\underline{?}$

2. $\underline{?}+8a+16$

(Students recite orally)

(QUESTIONS TO STUDENTS)

(Test papers passed in)

Multiply: (29)(31)

(QUESTION TO STUDENTS - will race students in multiplication)

Does this to introduce sum of two numbers times their difference

(LECTURE)

What is patterns in $(x+12)(x-12)$

$(29)(31)=(30-1)(30+1)=30^2-1^2=899$

(QUESTION TO STUDENTS)

(CHALK-TALK explanation of multiplication problem)

Do (46)(54) and (55)(65) in your head

(QUESTIONSTO STUDENTS)

The sum of two numbers times their difference is square of first minus square of second

(LECTURE)

(Assignment)

Factoring perfect square trinomials and product of sum and difference of two numbers

(CHALK-TALK)

$\sqrt{x^2+y^2}=+xy$

CONTROL GROUP

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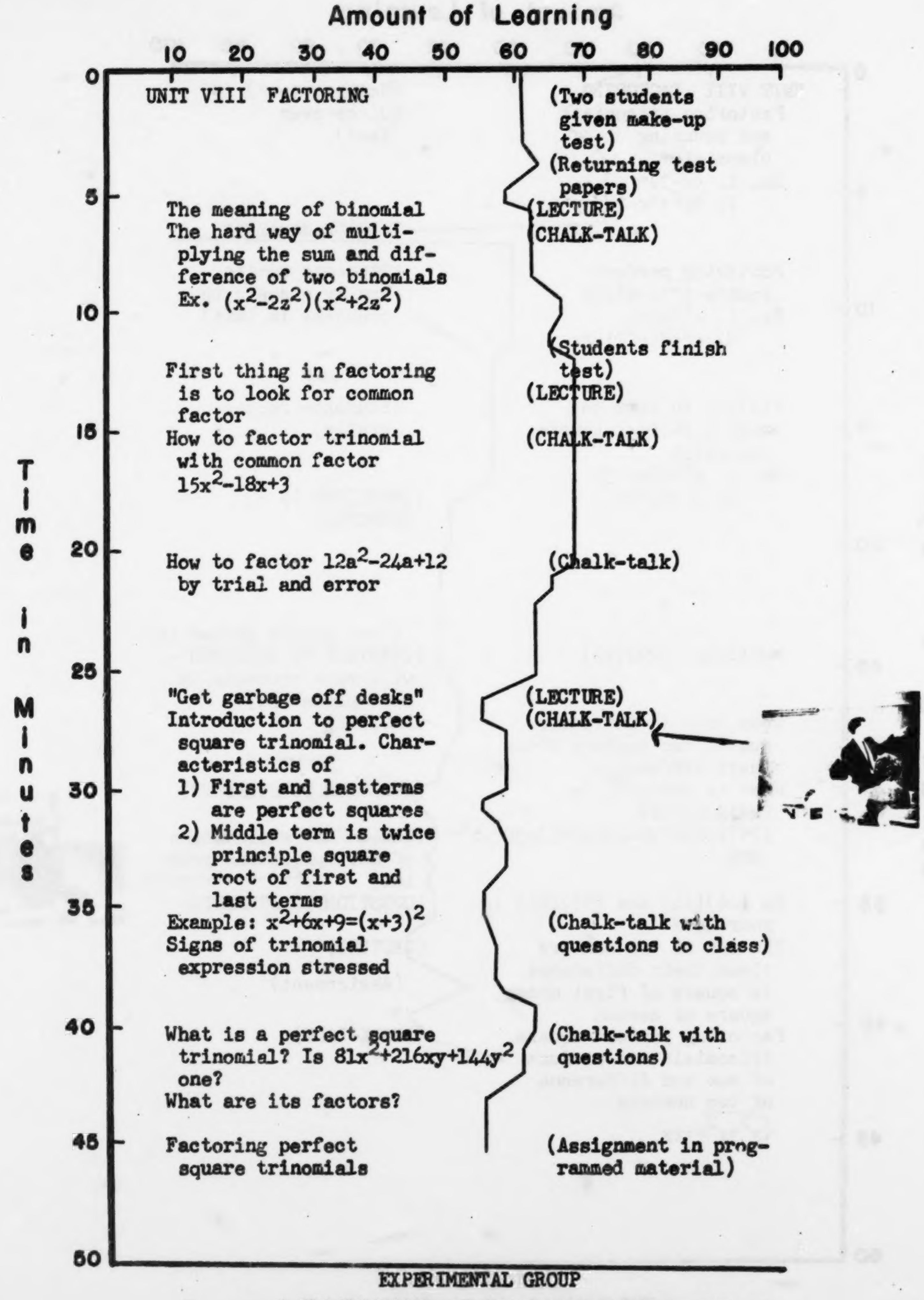

EXPERIMENTAL GROUP

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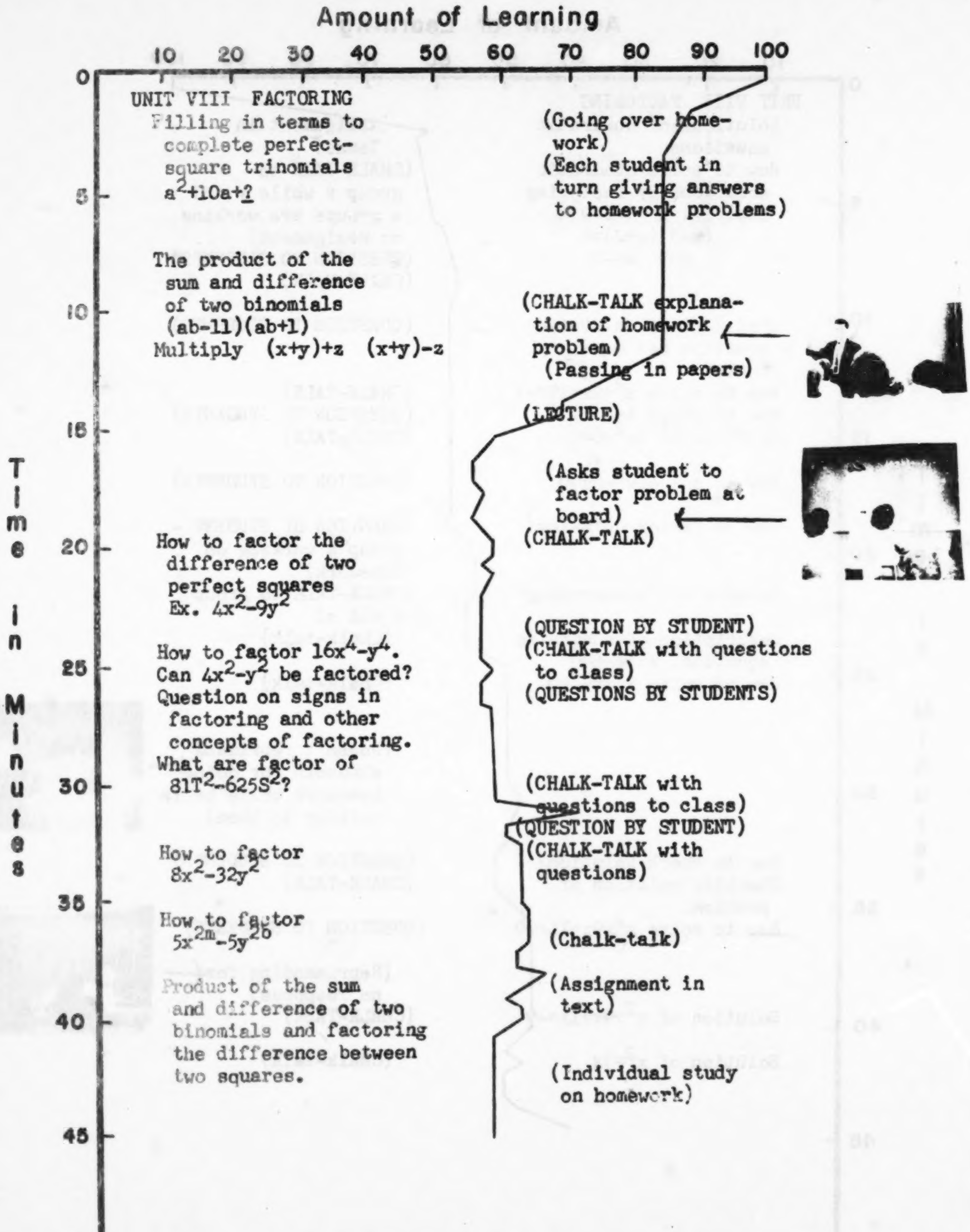

UNIT VIII FACTORING

Filling in terms to complete perfect-square trinomials $a^2+10a+?$

The product of the sum and difference of two binomials $(ab-11)(ab+1)$

Multiply $(x+y)+z$ $(x+y)-z$

How to factor the difference of two perfect squares Ex. $4x^2-9y^2$

How to factor $16x^4-y^4$.

Can $4x^2-y^2$ be factored?

Question on signs in factoring and other concepts of factoring.

What are factor of $81T^2-625S^2$?

How to factor $8x^2-32y^2$

How to factor $5x^{2m}-5y^{2b}$

Product of the sum and difference of two binomials and factoring the difference between two squares.

(Going over homework)

(Each student in turn giving answers to homework problems)

(CHALK-TALK explanation of homework problem)

(Passing in papers)

(LECTURE)

(Asks student to factor problem at board)

(CHALK-TALK)

(QUESTION BY STUDENT)

(CHALK-TALK with questions to class)

(QUESTIONS BY STUDENTS)

(CHALK-TALK with questions to class)

(QUESTION BY STUDENT)

(CHALK-TALK with questions)

(Chalk-talk)

(Assignment in text)

(Individual study on homework)

CONTROL GROUP

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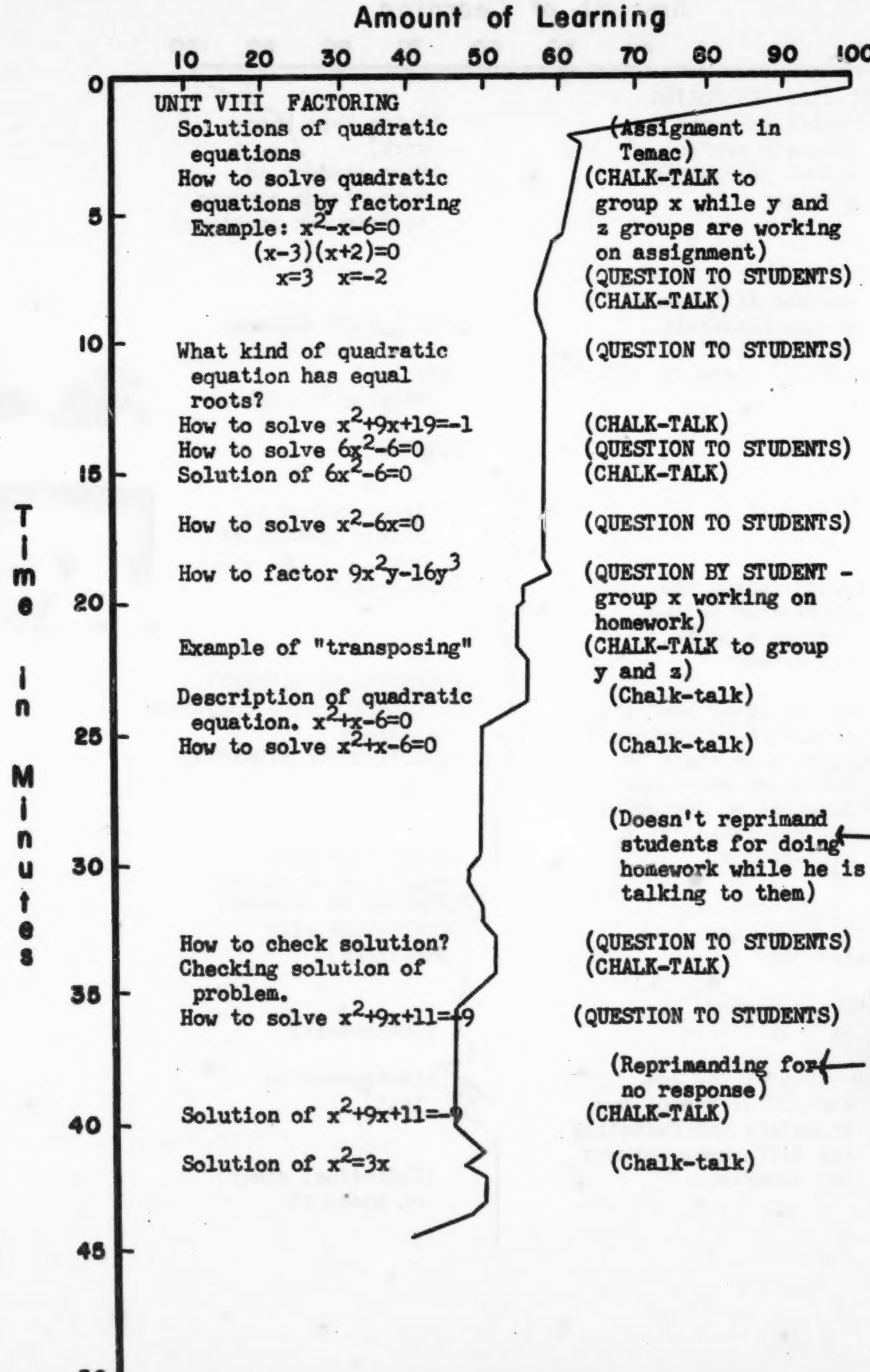

UNIT VIII FACTORING	
Solutions of quadratic equations	(Assignment in Temac)
How to solve quadratic equations by factoring	(CHALK-TALK to group x while y and z groups are working on assignment)
Example: $x^2-x-6=0$ $(x-3)(x+2)=0$ $x=3 \quad x=-2$	(QUESTION TO STUDENTS) (CHALK-TALK)
What kind of quadratic equation has equal roots?	(QUESTION TO STUDENTS)
How to solve $x^2+9x+19=-1$	(CHALK-TALK)
How to solve $6x^2-6=0$	(QUESTION TO STUDENTS)
Solution of $6x^2-6=0$	(CHALK-TALK)
How to solve $x^2-6x=0$	(QUESTION TO STUDENTS)
How to factor $9x^2y-16y^3$	(QUESTION BY STUDENT - group x working on homework)
Example of "transposing"	(CHALK-TALK to group y and z)
Description of quadratic equation. $x^2+x-6=0$	(Chalk-talk)
How to solve $x^2+x-6=0$	(Chalk-talk)
	(Doesn't reprimand students for doing homework while he is talking to them)
How to check solution?	(QUESTION TO STUDENTS)
Checking solution of problem.	(CHALK-TALK)
How to solve $x^2+9x+11=-9$	(QUESTION TO STUDENTS)
	(Reprimanding for no response)
Solution of $x^2+9x+11=-9$	(CHALK-TALK)
Solution of $x^2=3x$	(Chalk-talk)

EXPERIMENTAL GROUP

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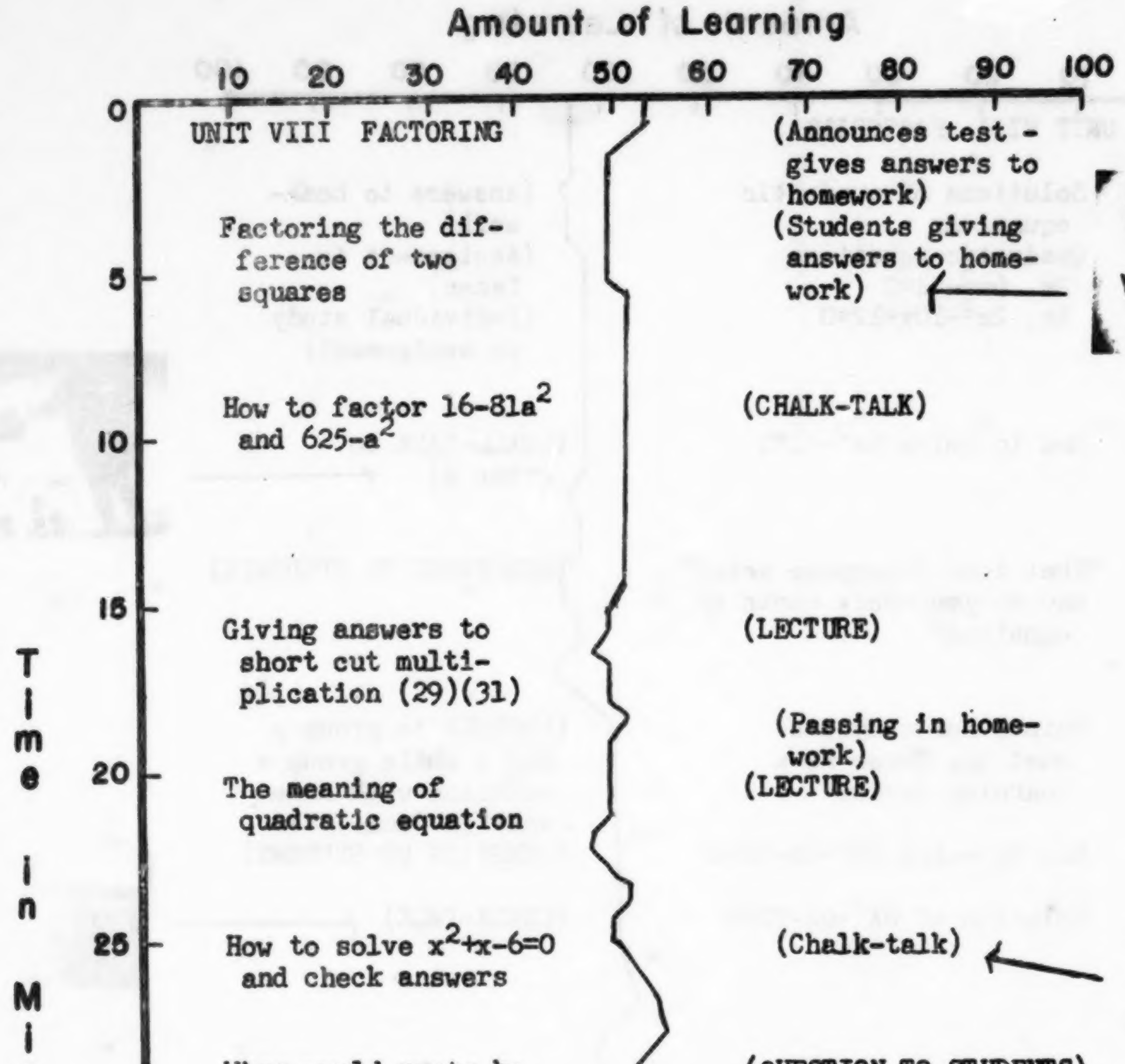

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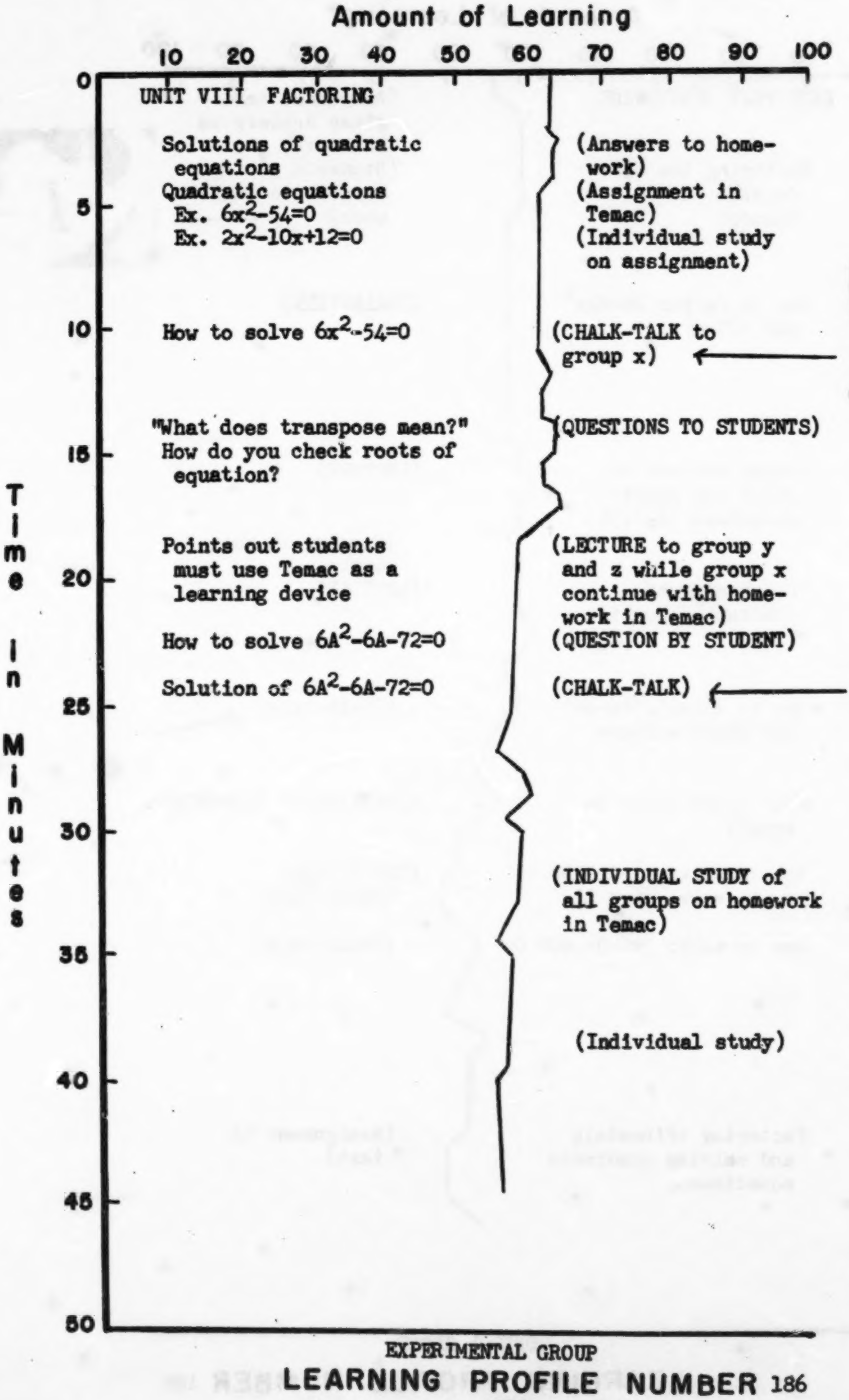


UNIT VIII FACTORING

Solutions of quadratic equations

Quadratic equations

Ex. $6x^2-54=0$

Ex. $2x^2-10x+12=0$

(Answers to homework)

(Assignment in Temac)

(Individual study on assignment)

How to solve $6x^2-54=0$

(CHALK-TALK to group x)

"What does transpose mean?"

How do you check roots of equation?

(QUESTIONS TO STUDENTS)

Points out students must use Temac as a learning device

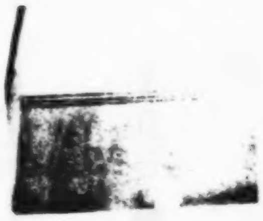
(LECTURE to group y and z while group x continue with homework in Temac)

How to solve $6A^2-6A-72=0$

(QUESTION BY STUDENT)

Solution of $6A^2-6A-72=0$

(CHALK-TALK)



(INDIVIDUAL STUDY of all groups on homework in Temac)

(Individual study)

EXPERIMENTAL GROUP

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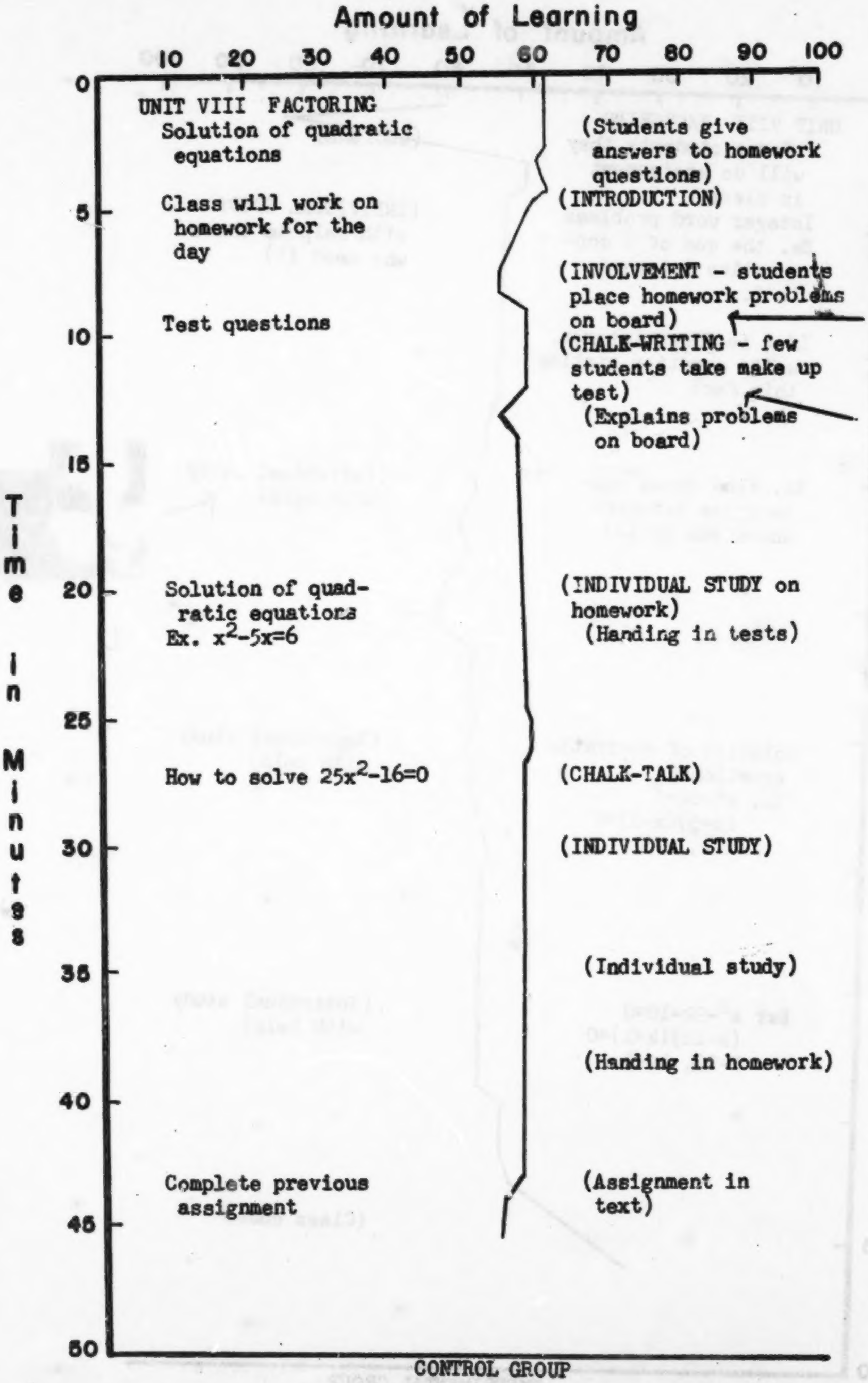

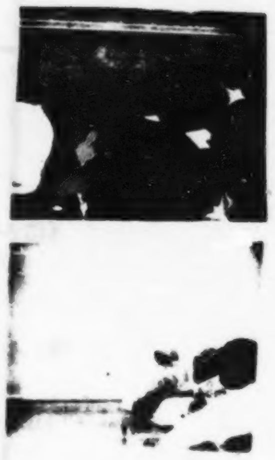

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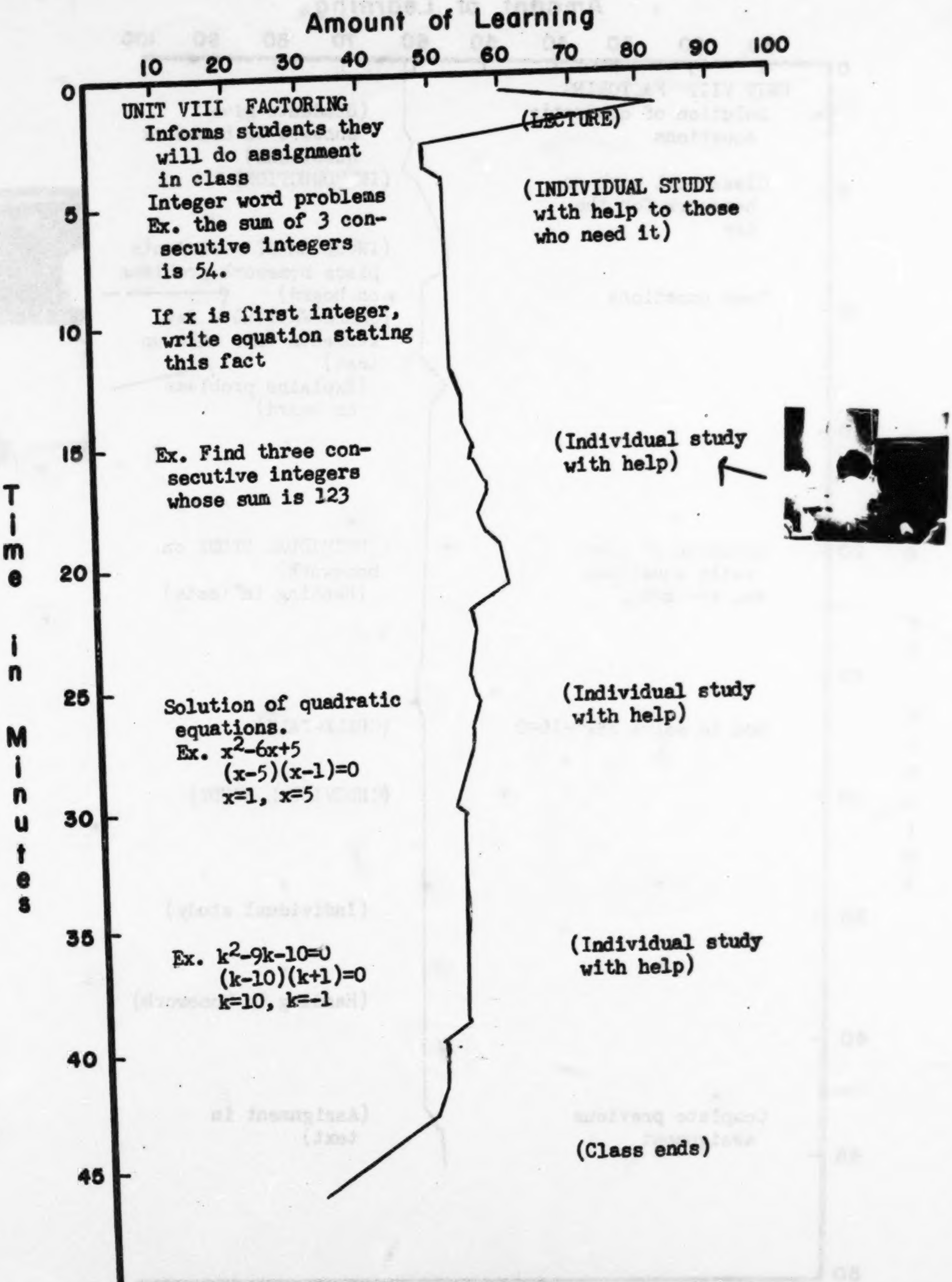

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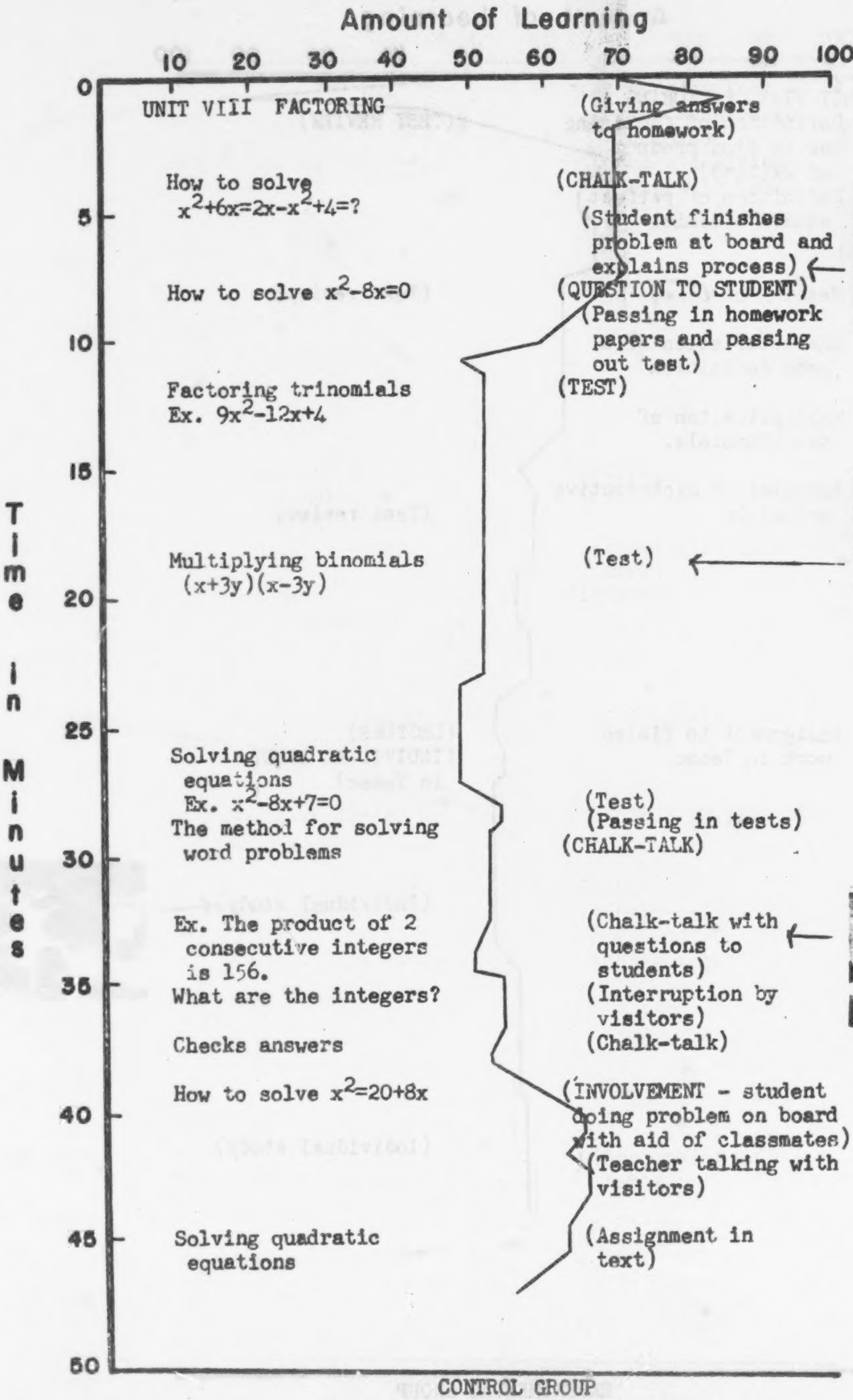

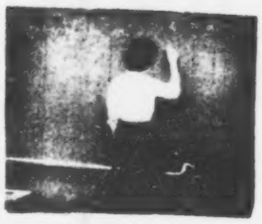

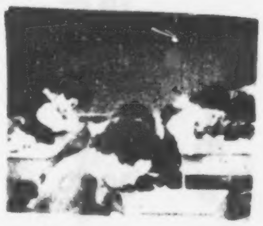

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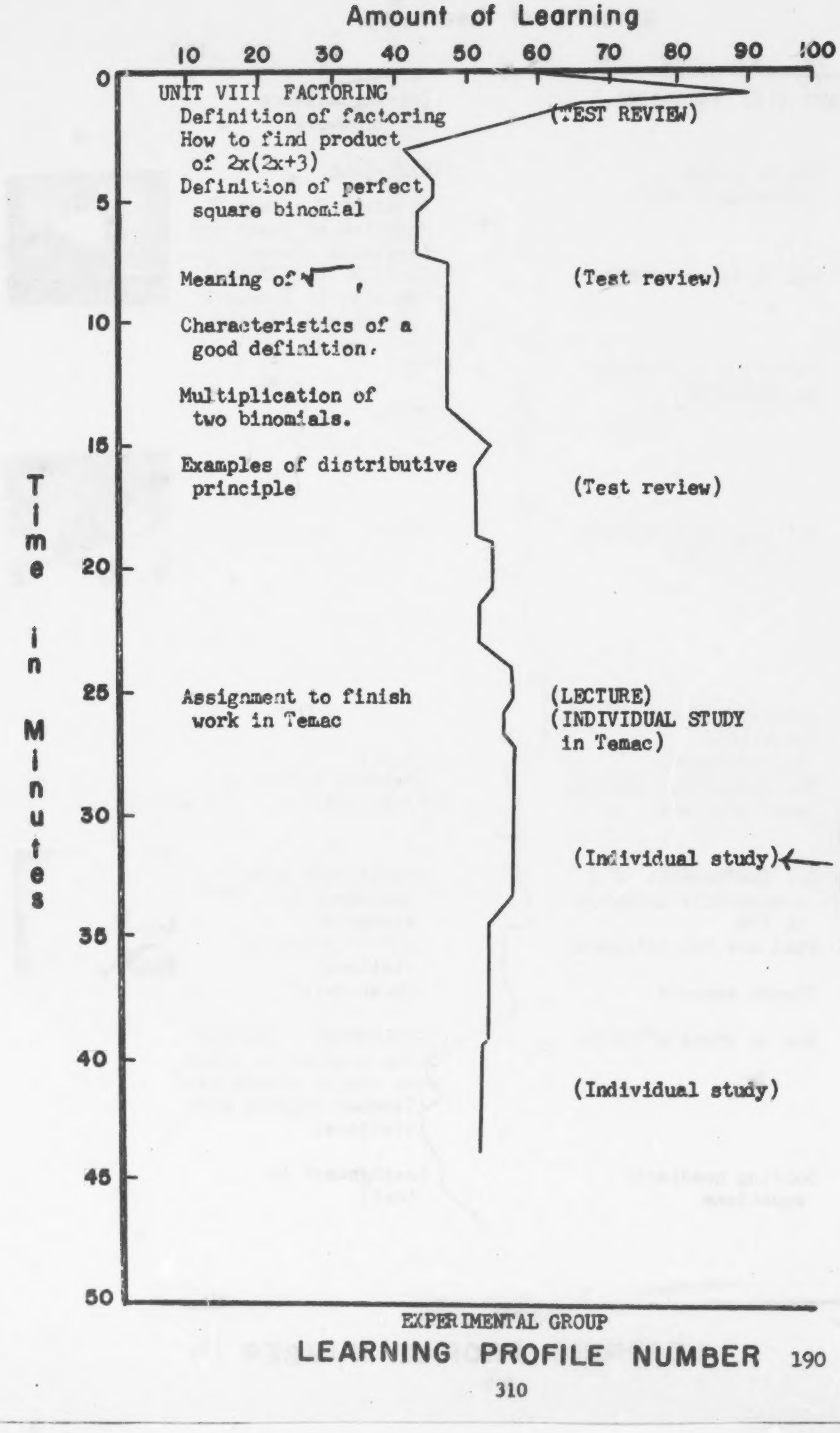

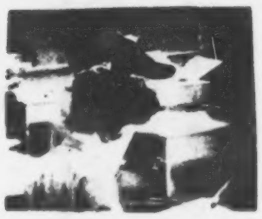

EXPERIMENTAL GROUP

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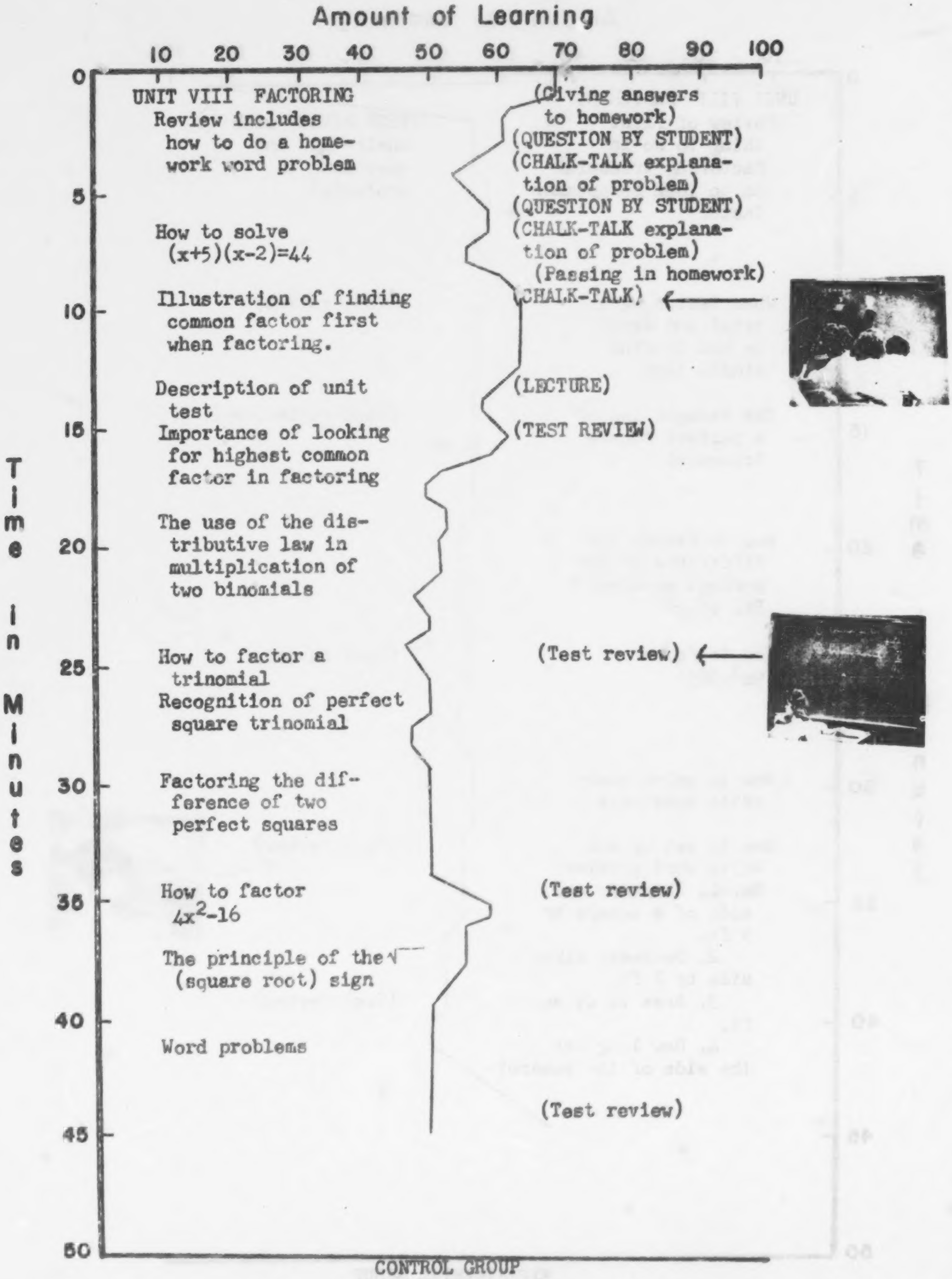

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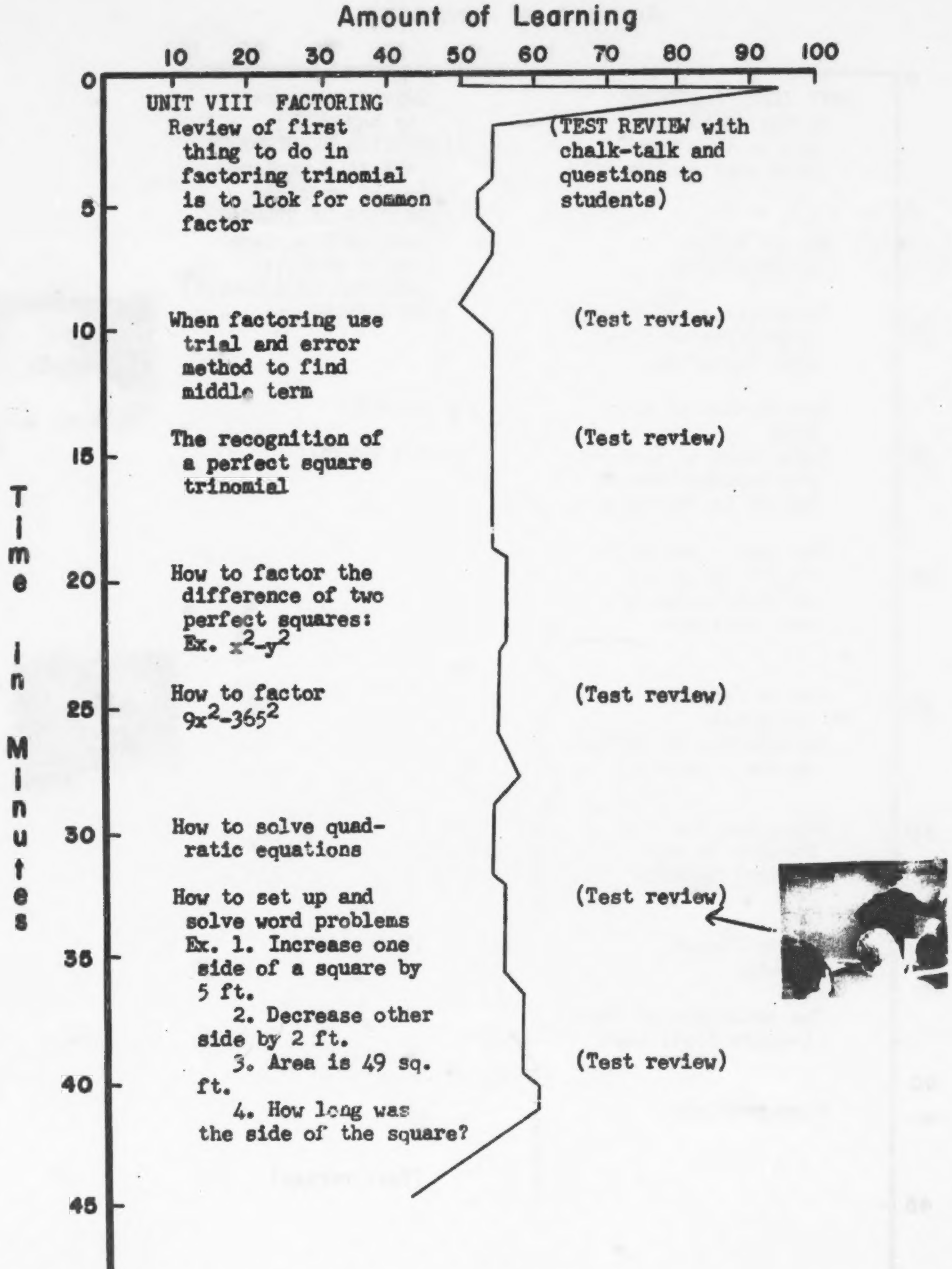

UNIT VIII FACTORING

Review of first thing to do in factoring trinomial is to look for common factor

(TEST REVIEW with chalk-talk and questions to students)

When factoring use trial and error method to find middle term

(Test review)

The recognition of a perfect square trinomial

(Test review)

How to factor the difference of two perfect squares: Ex. x^2-y^2

How to factor $9x^2-365^2$

(Test review)

How to solve quadratic equations

How to set up and solve word problems

Ex. 1. Increase one side of a square by 5 ft.

2. Decrease other side by 2 ft.

3. Area is 49 sq. ft.

4. How long was the side of the square?

(Test review)

(Test review)

EXPERIMENTAL GROUP

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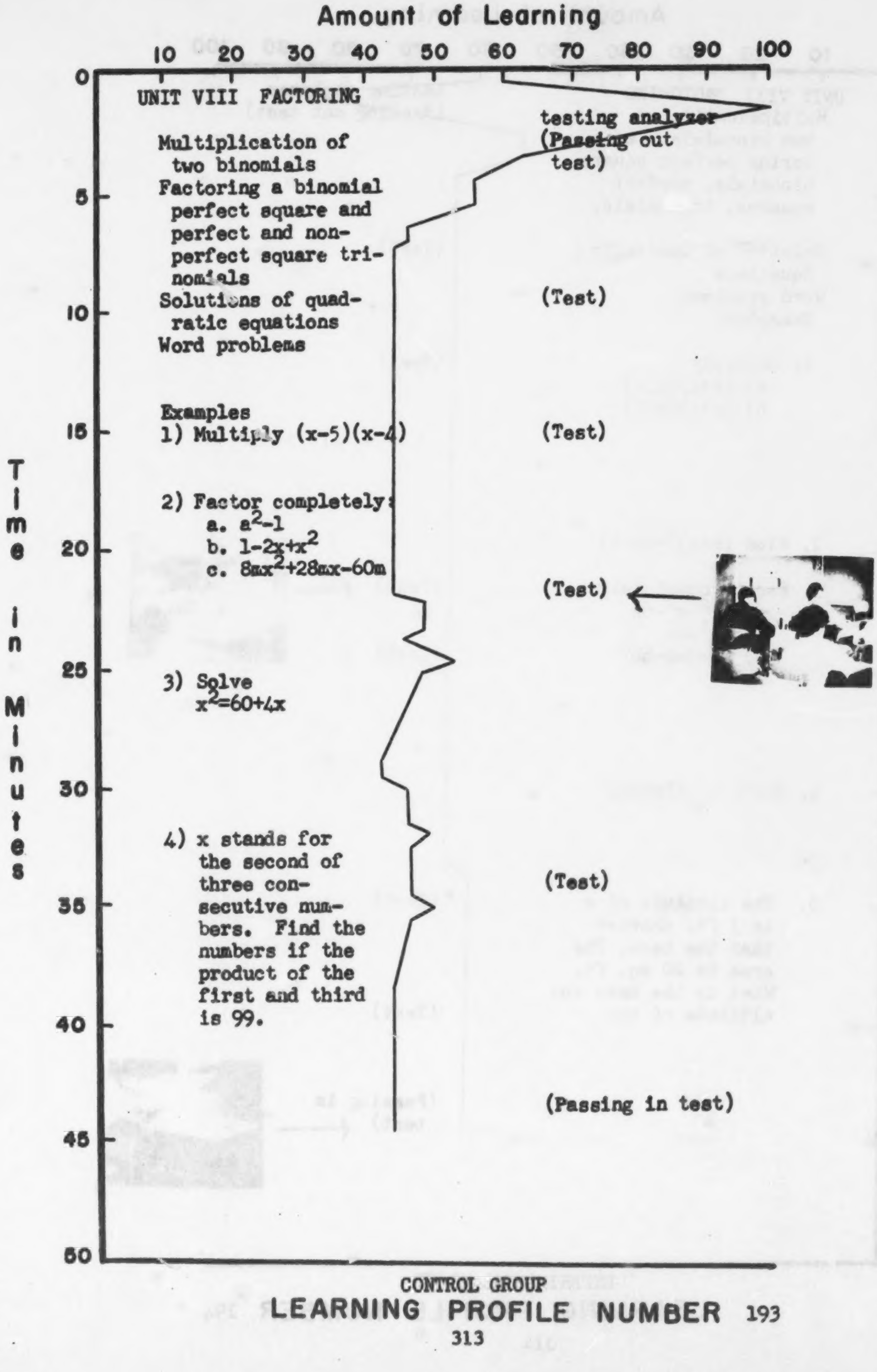

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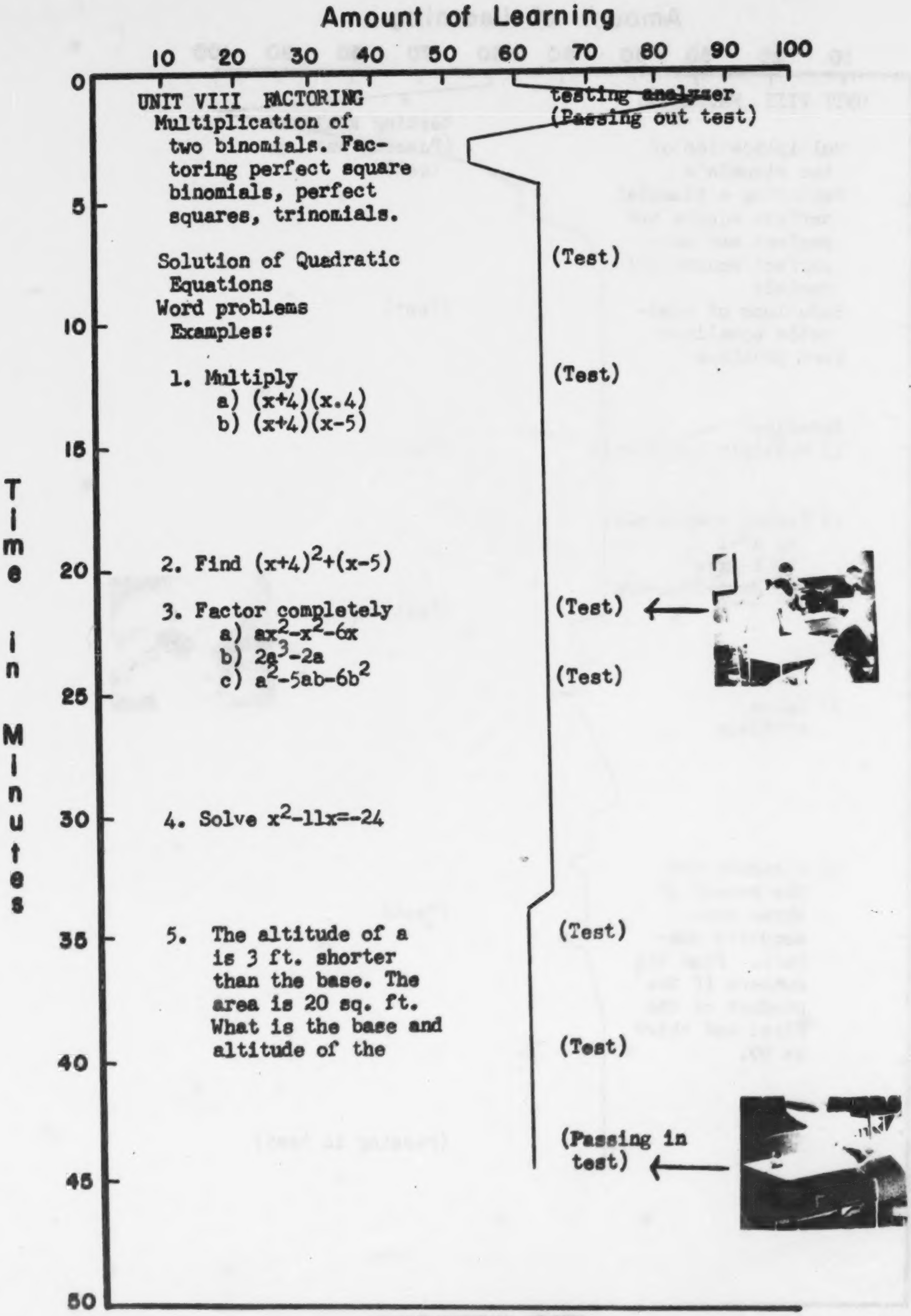

UNIT VIII FACTORING

Multiplication of two binomials. Factoring perfect square binomials, perfect squares, trinomials.

Solution of Quadratic Equations

Word problems

Examples:

1. Multiply
   a) $(x+4)(x.4)$
   b) $(x+4)(x-5)$

2. Find $(x+4)^2+(x-5)$

3. Factor completely
   a) ax^2-x^2-6x
   b) $2a^3-2a$
   c) $a^2-5ab-6b^2$

4. Solve $x^2-11x=-24$

5. The altitude of a is 3 ft. shorter than the base. The area is 20 sq. ft. What is the base and altitude of the

EXPERIMENTAL GROUP

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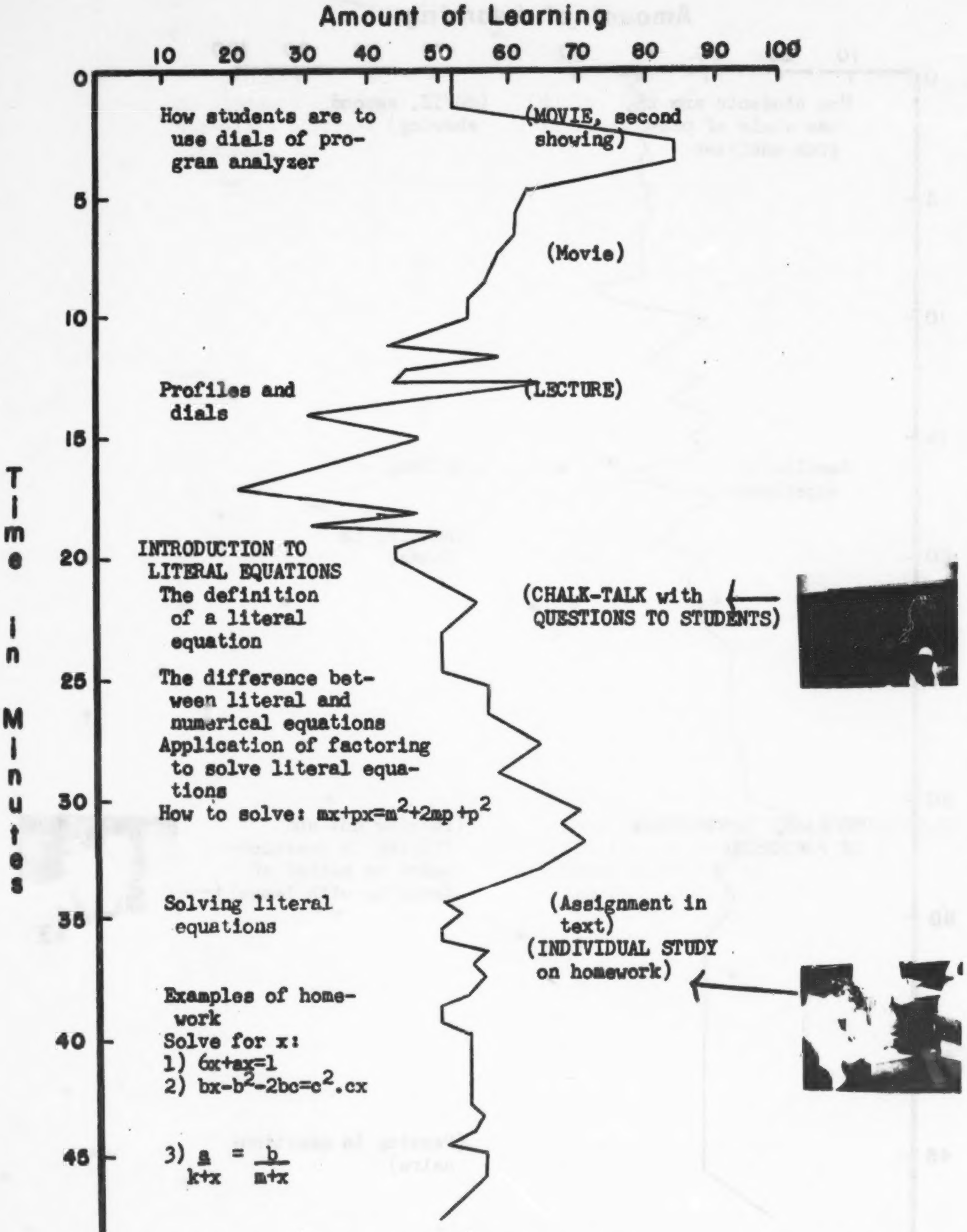

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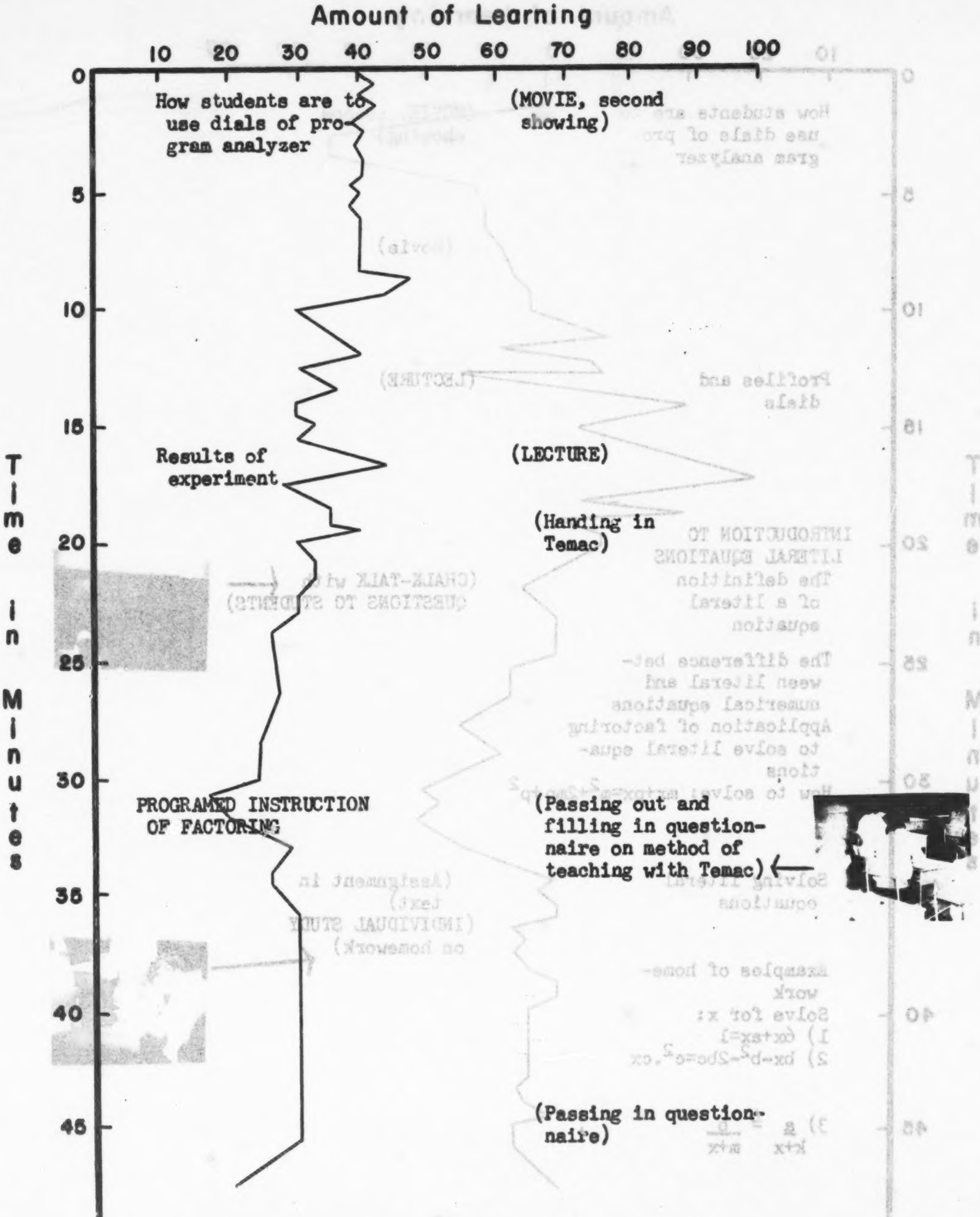

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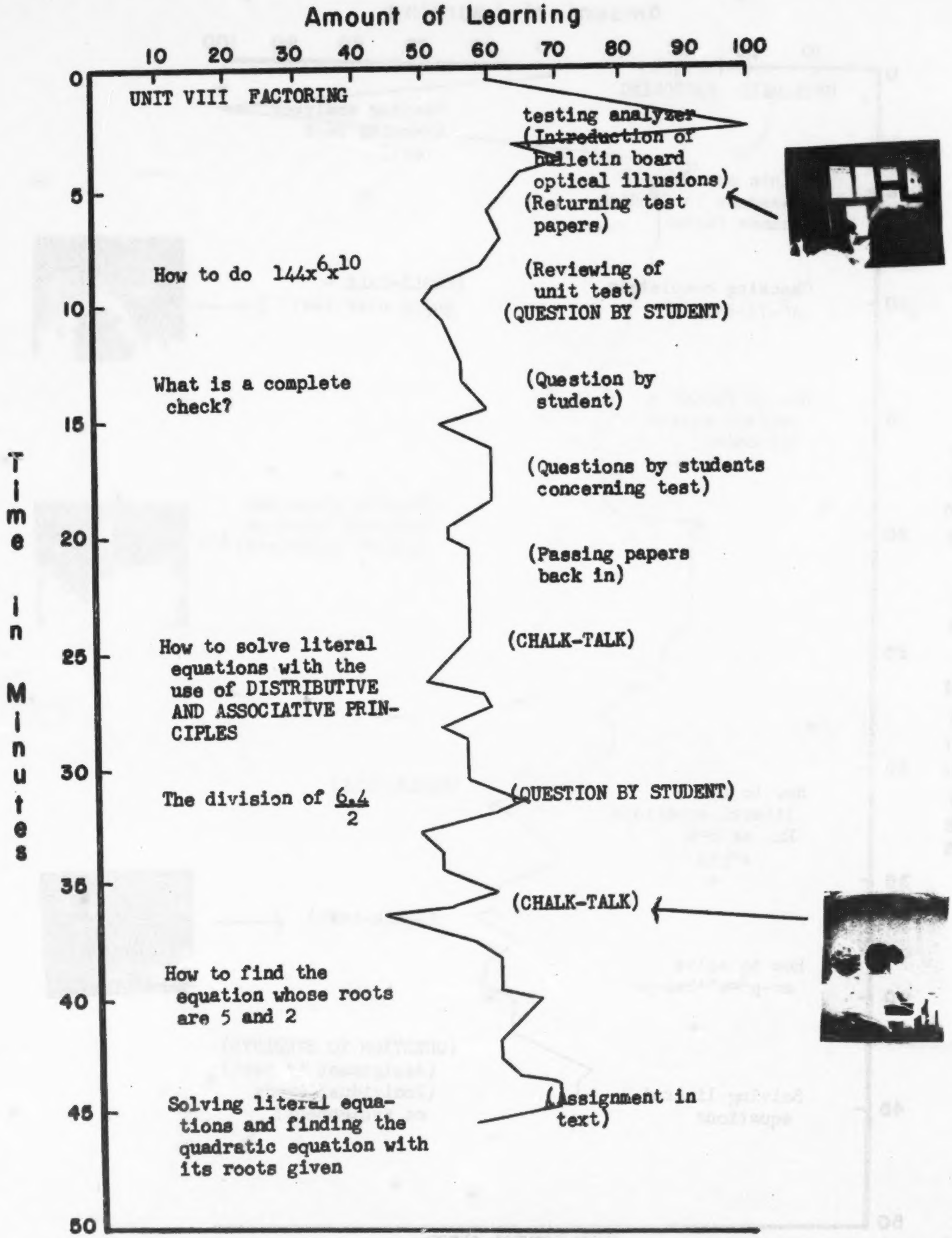

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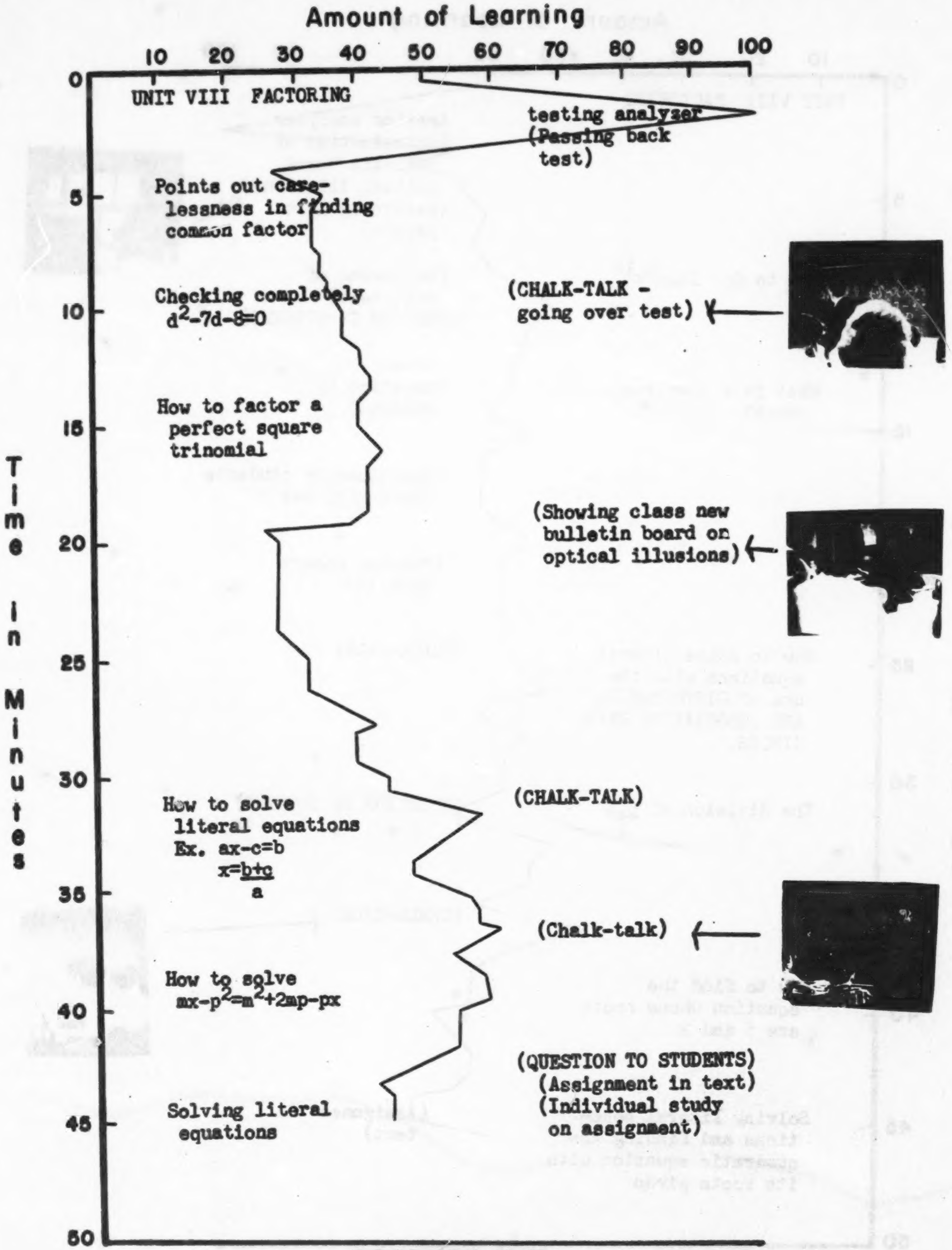

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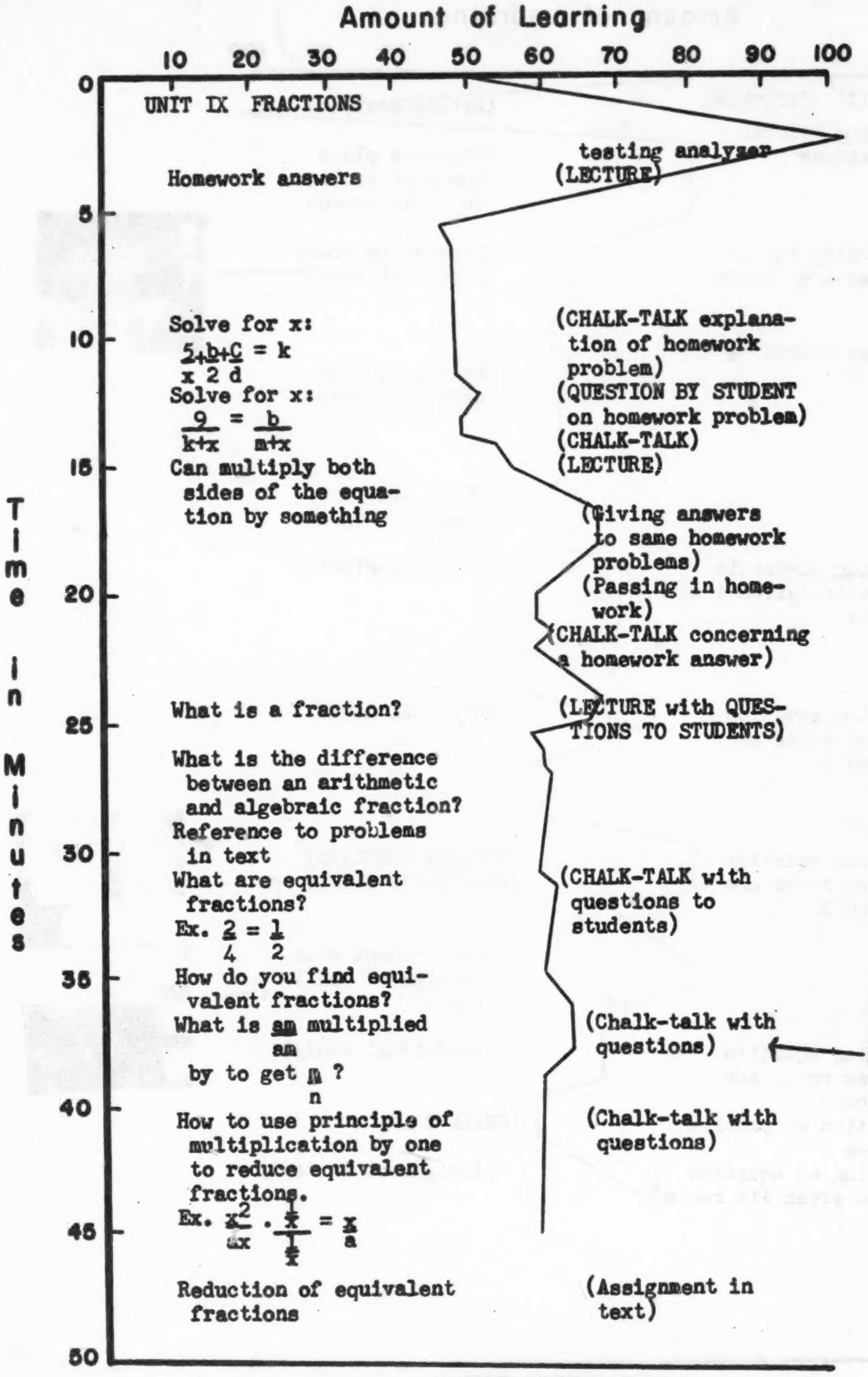

UNIT IX FRACTIONS

testing analyzer
(LECTURE)

Homework answers

Solve for x:
$\frac{5}{x}+\frac{b}{2}+\frac{C}{d} = k$

(CHALK-TALK explanation of homework problem)

Solve for x:
$\frac{9}{k+x} = \frac{b}{m+x}$

(QUESTION BY STUDENT on homework problem)
(CHALK-TALK)
(LECTURE)

Can multiply both sides of the equation by something

(Giving answers to same homework problems)
(Passing in homework)
(CHALK-TALK concerning a homework answer)

What is a fraction?

(LECTURE with QUESTIONS TO STUDENTS)

What is the difference between an arithmetic and algebraic fraction?

Reference to problems in text

What are equivalent fractions?
Ex. $\frac{2}{4} = \frac{1}{2}$

(CHALK-TALK with questions to students)

How do you find equivalent fractions?

What is $\frac{am}{am}$ multiplied by to get $\frac{m}{n}$?

(Chalk-talk with questions)

How to use principle of multiplication by one to reduce equivalent fractions.
Ex. $\frac{x^2}{ax} \cdot \frac{\frac{1}{x}}{\frac{1}{x}} = \frac{x}{a}$

(Chalk-talk with questions)

Reduction of equivalent fractions

(Assignment in text)

CONTROL GROUP
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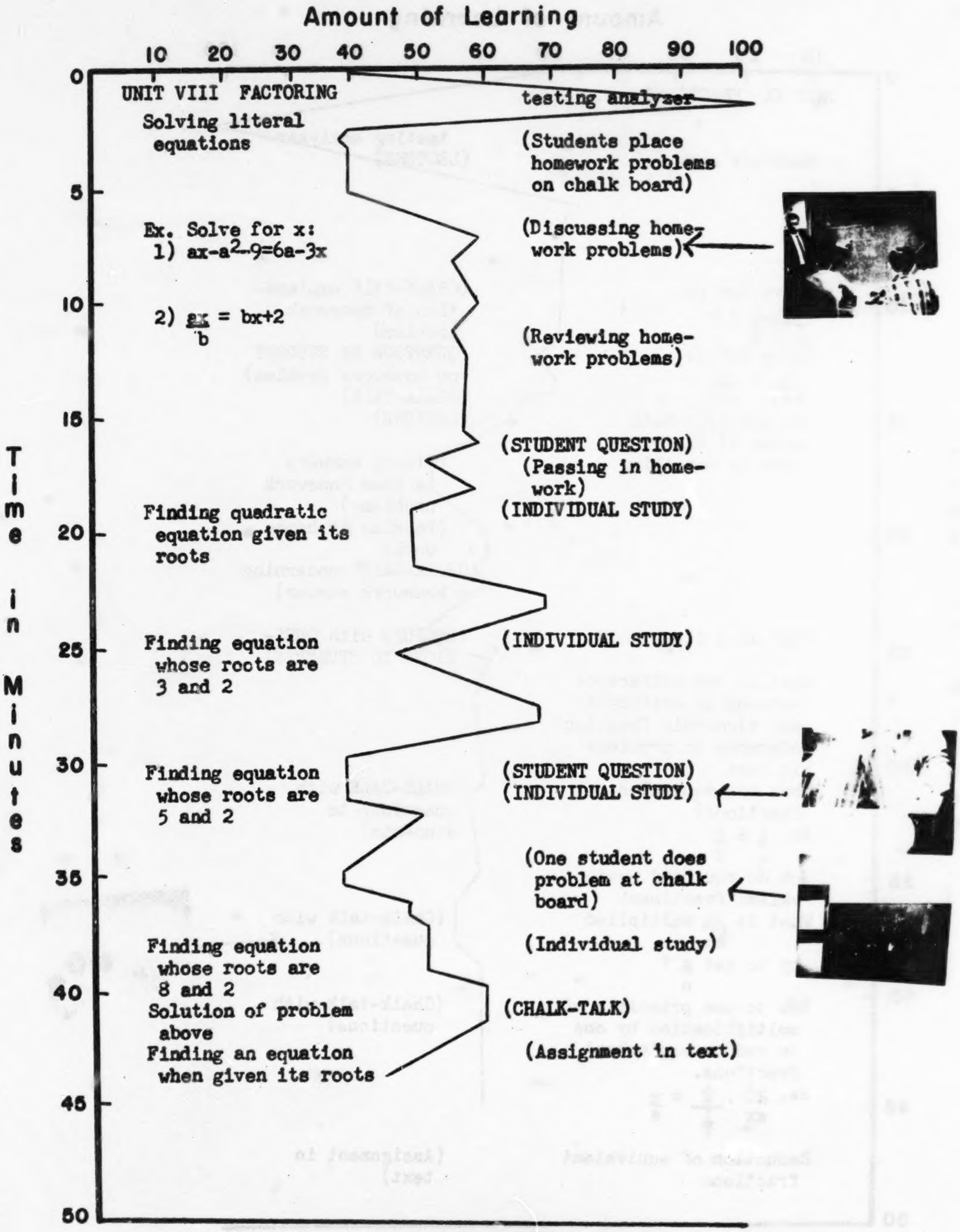

EXPERIMENTAL GROUP

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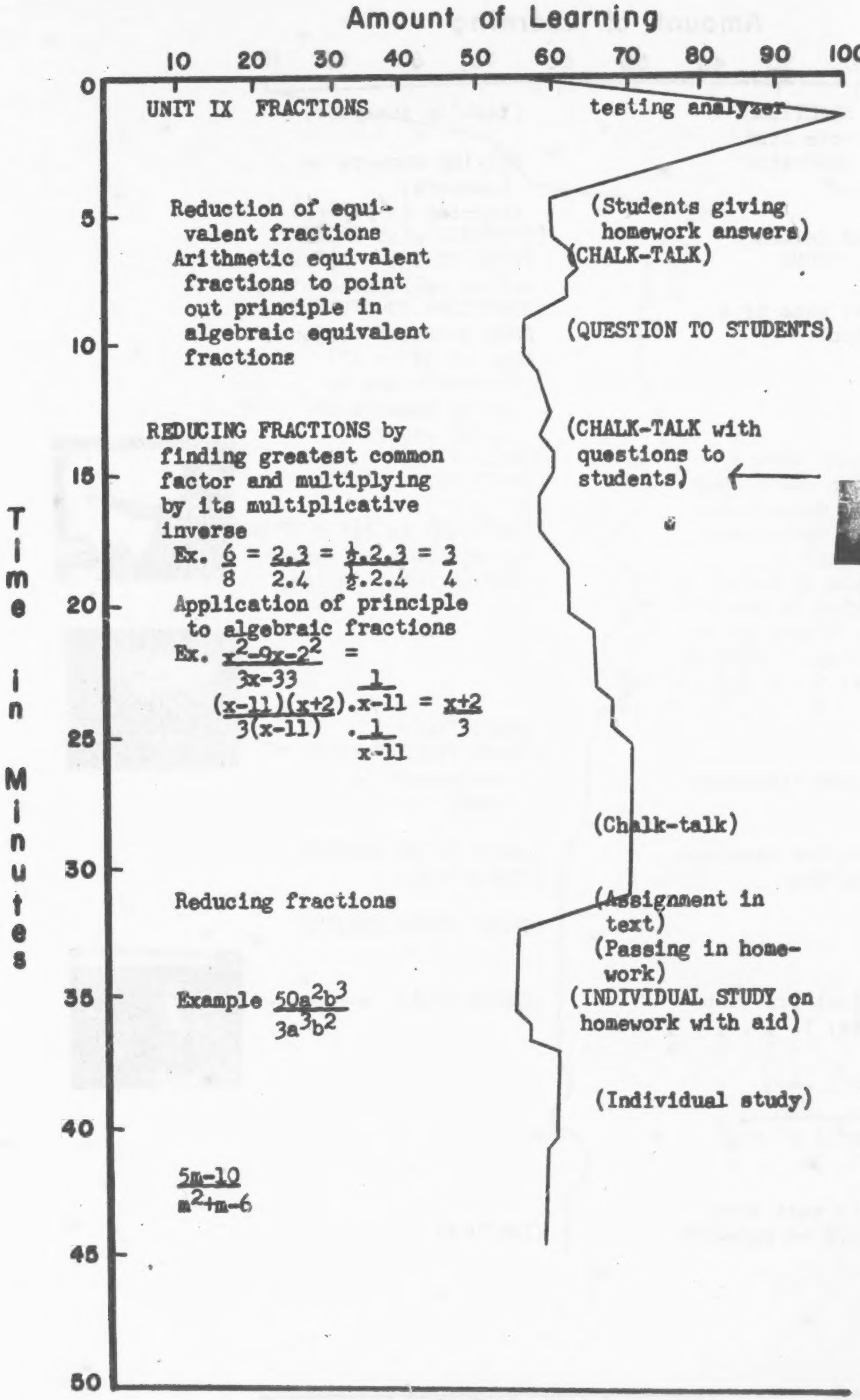

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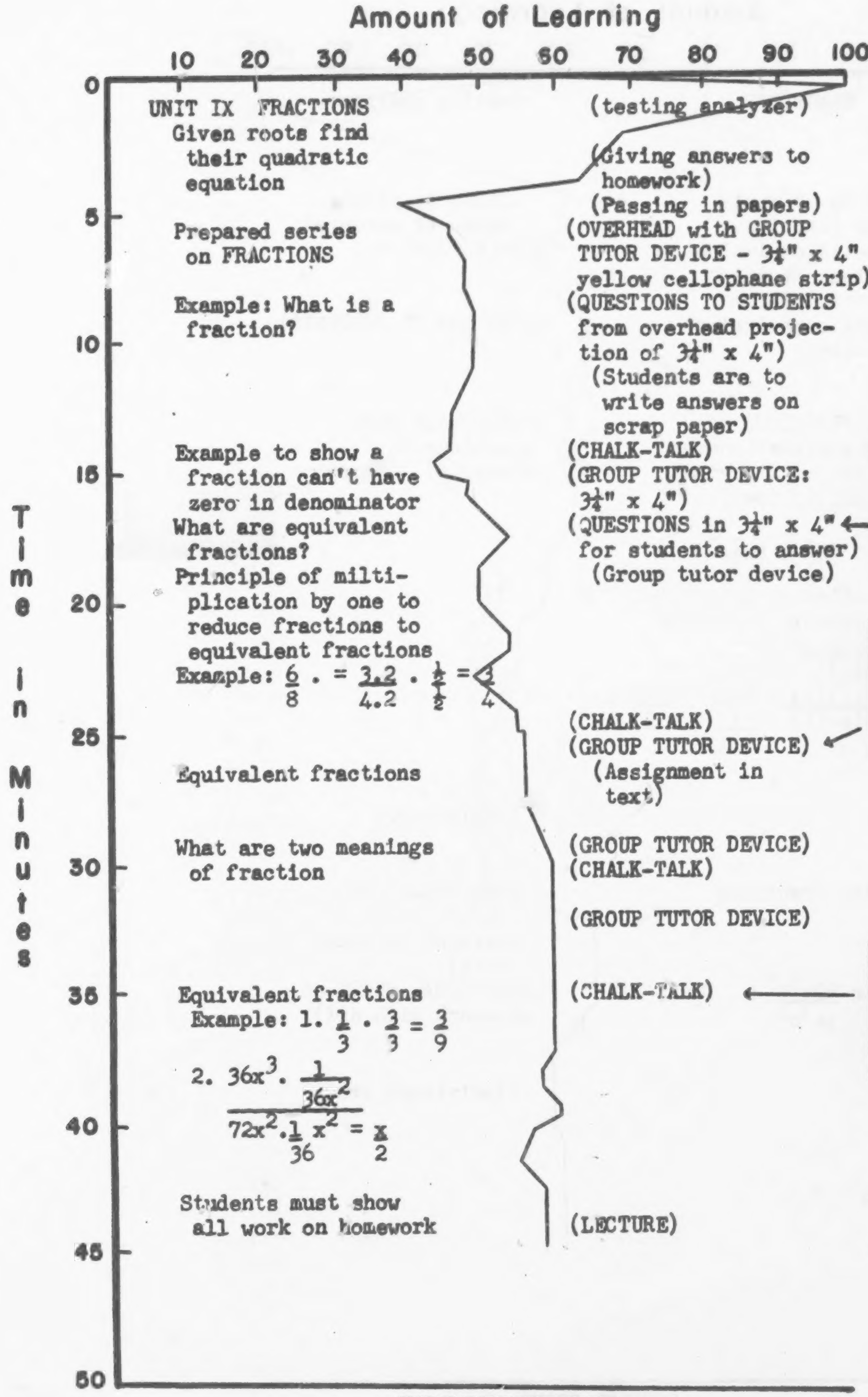

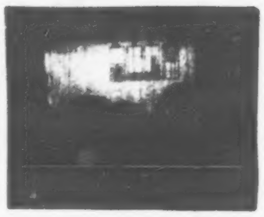

EXPERIMENTAL GROUP

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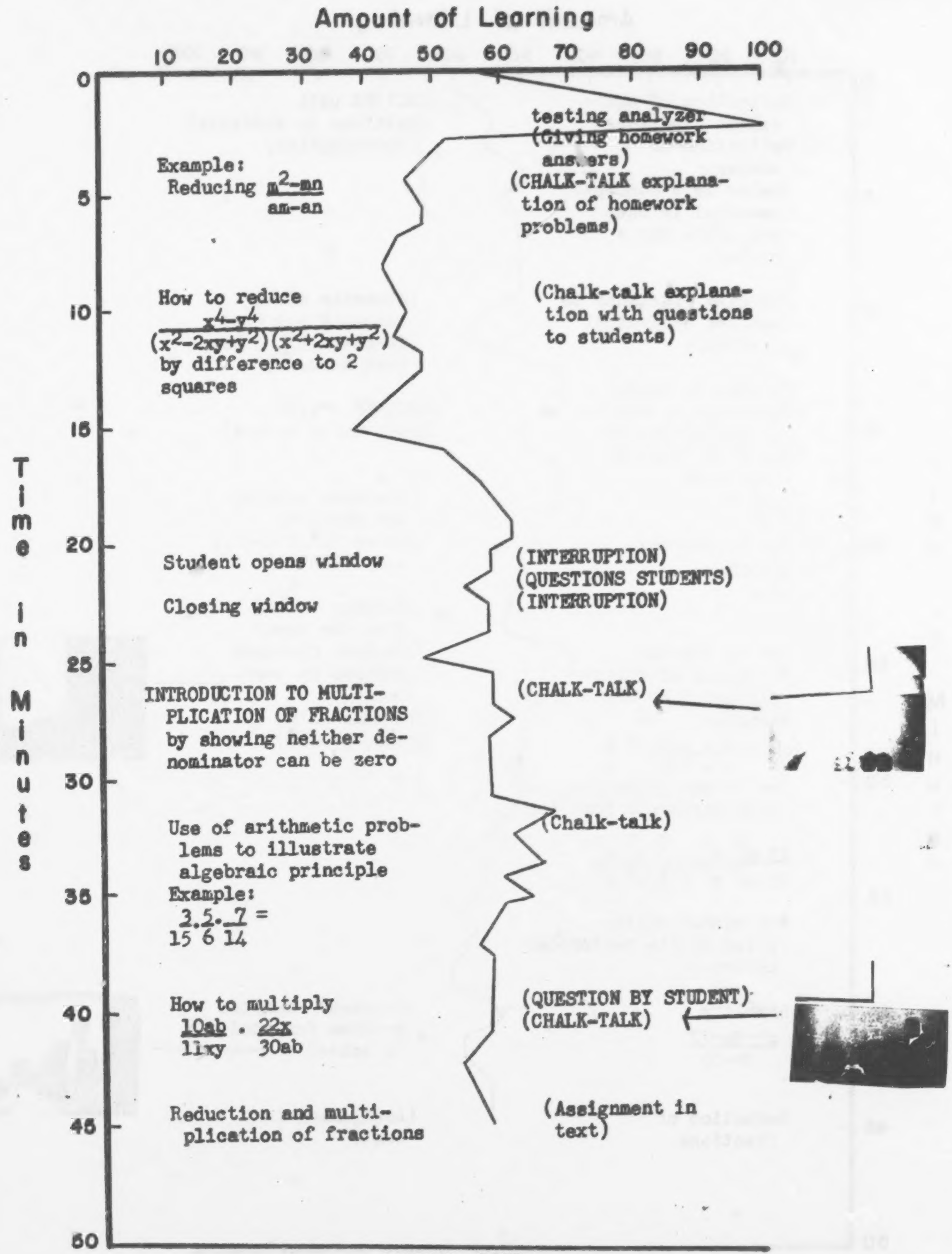

CONTROL GROUP

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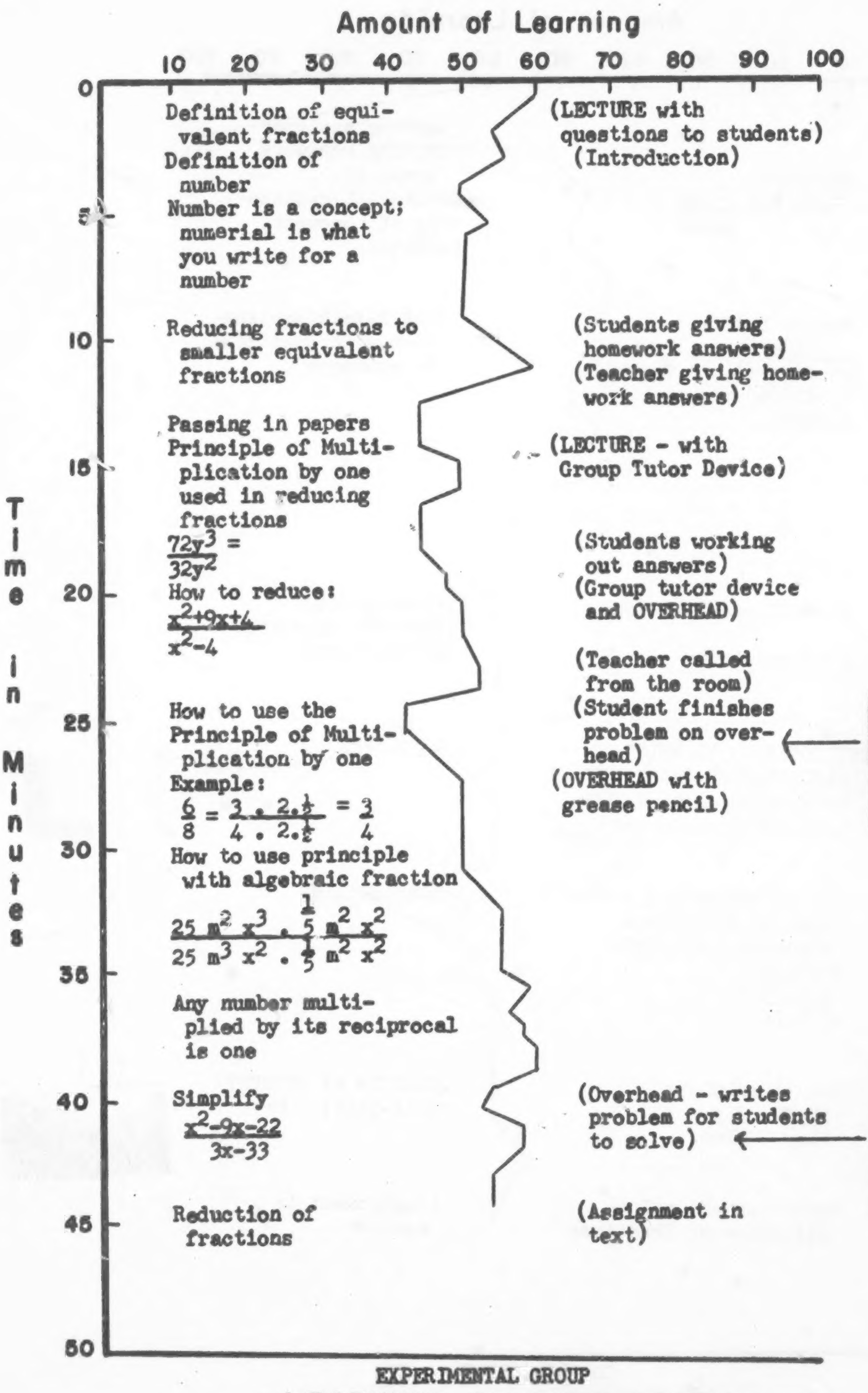


Definition of equivalent fractions

Definition of number

Number is a concept; numerial is what you write for a number

(LECTURE with questions to students)
(Introduction)

Reducing fractions to smaller equivalent fractions

(Students giving homework answers)
(Teacher giving homework answers)

Passing in papers

Principle of Multiplication by one used in reducing fractions

(LECTURE - with Group Tutor Device)

$\frac{72y^3}{32y^2} =$

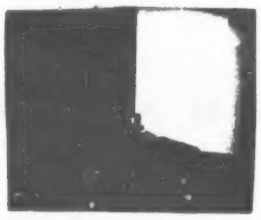
(Students working out answers)
(Group tutor device and OVERHEAD)

How to reduce:
$\frac{x^2+9x+4}{x^2-4}$

(Teacher called from the room)
(Student finishes problem on overhead)
(OVERHEAD with grease pencil)

How to use the Principle of Multiplication by one

Example:
$\frac{6}{8} = \frac{3 \cdot 2 \cdot \frac{1}{2}}{4 \cdot 2 \cdot \frac{1}{2}} = \frac{3}{4}$



How to use principle with algebraic fraction

$\frac{25\,m^2\,x^3 \cdot \frac{1}{5}\,m^2\,x^2}{25\,m^3\,x^2 \cdot \frac{1}{5}\,m^2\,x^2}$

Any number multiplied by its reciprocal is one

Simplify
$\frac{x^2-9x-22}{3x-33}$

(Overhead - writes problem for students to solve)

Reduction of fractions

(Assignment in text)

EXPERIMENTAL GROUP

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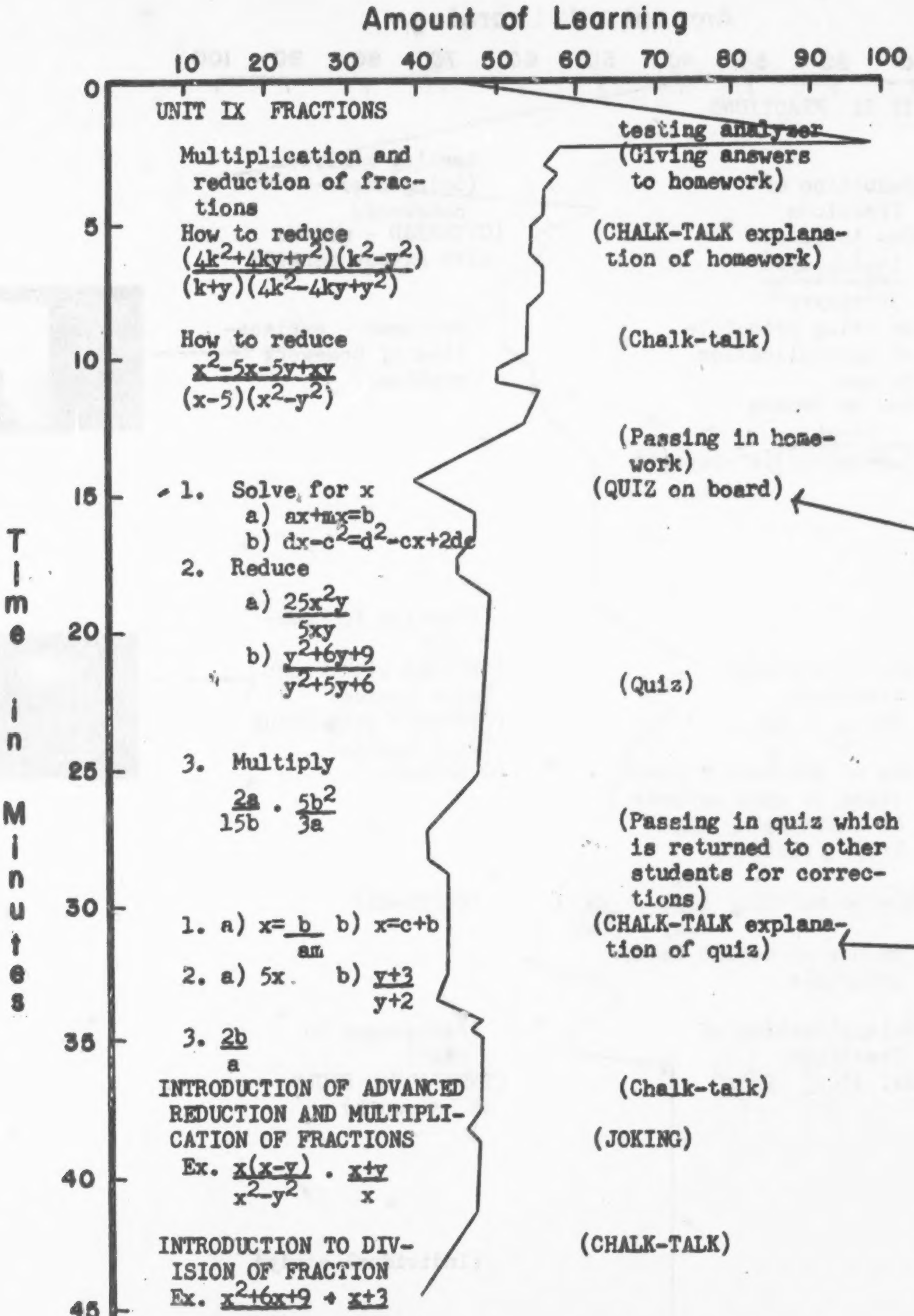

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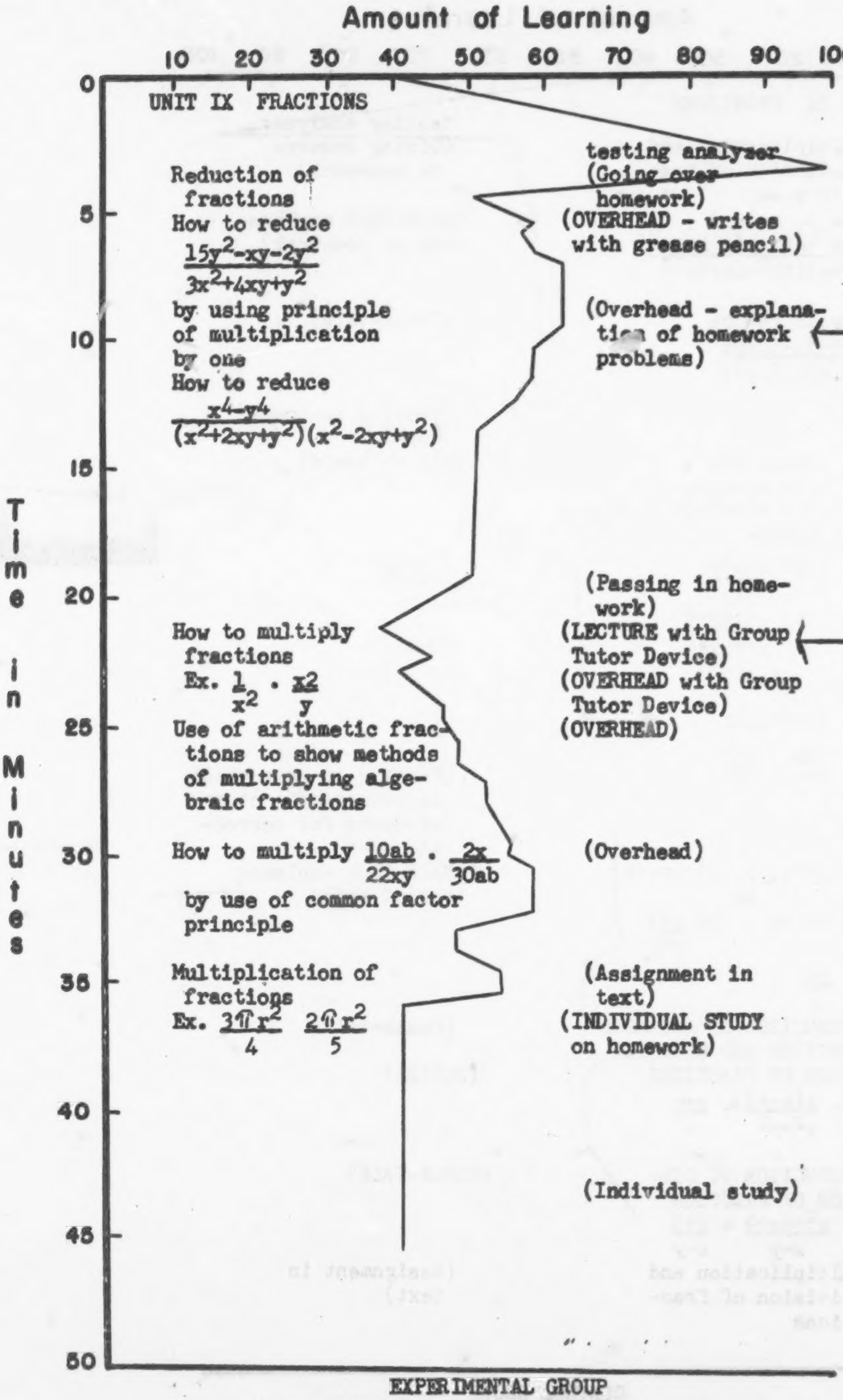

EXPERIMENTAL GROUP

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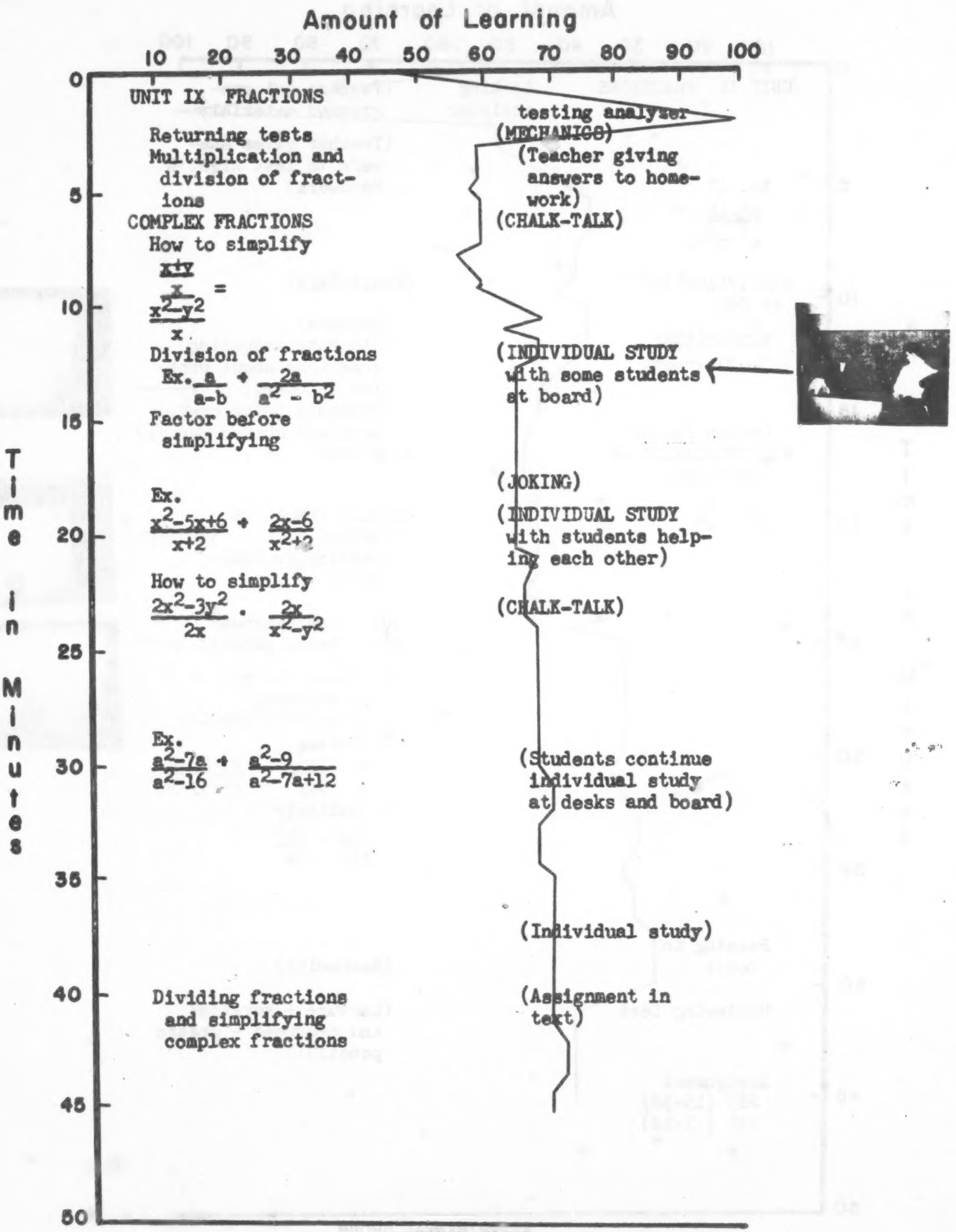

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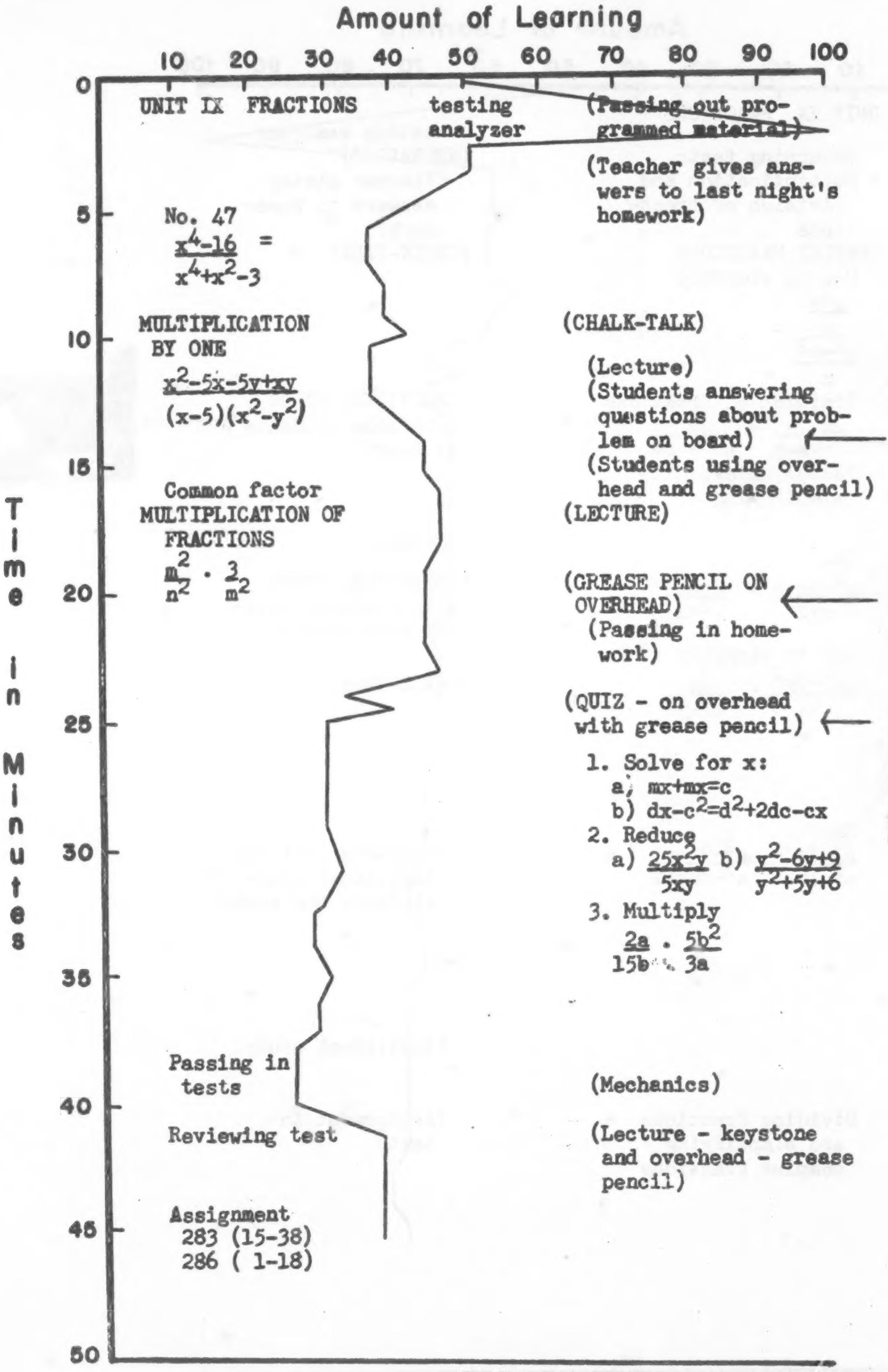
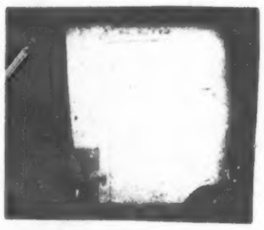
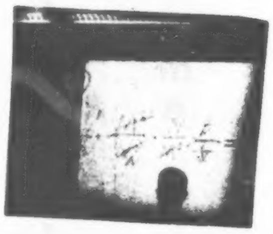
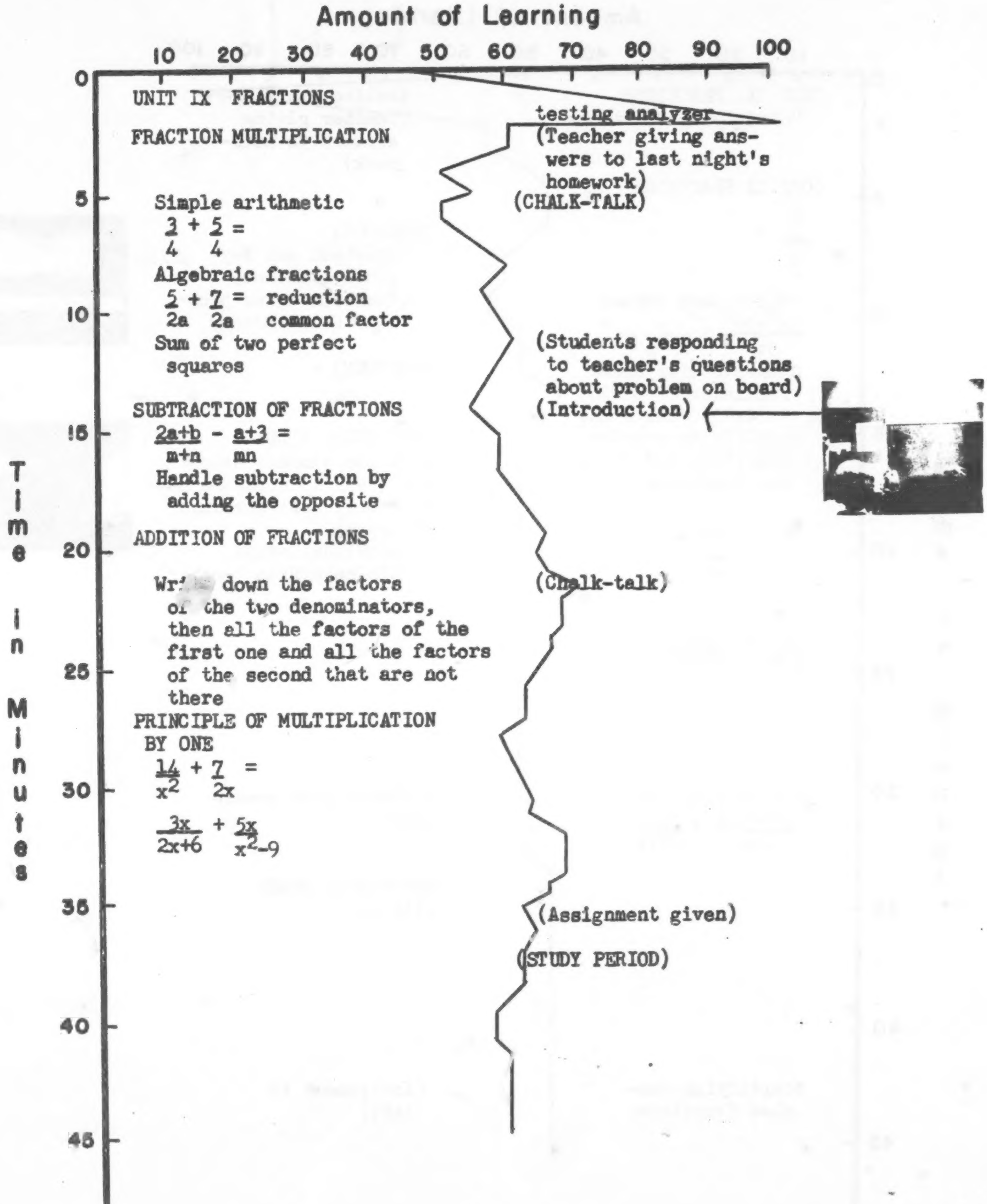






EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 208



CONTROL GROUP

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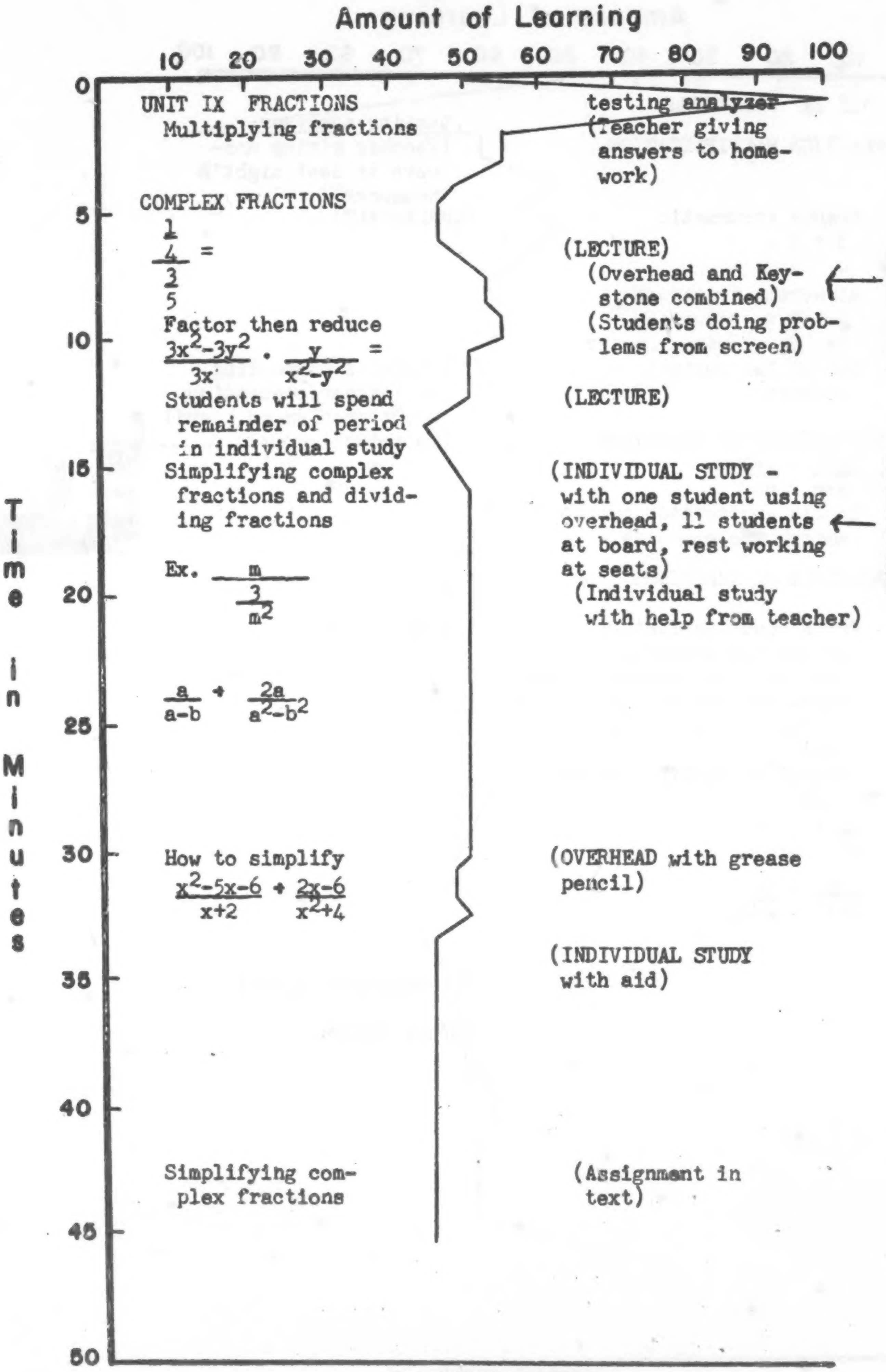

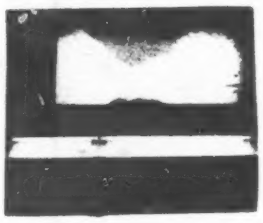

EXPERIMENTAL GROUP

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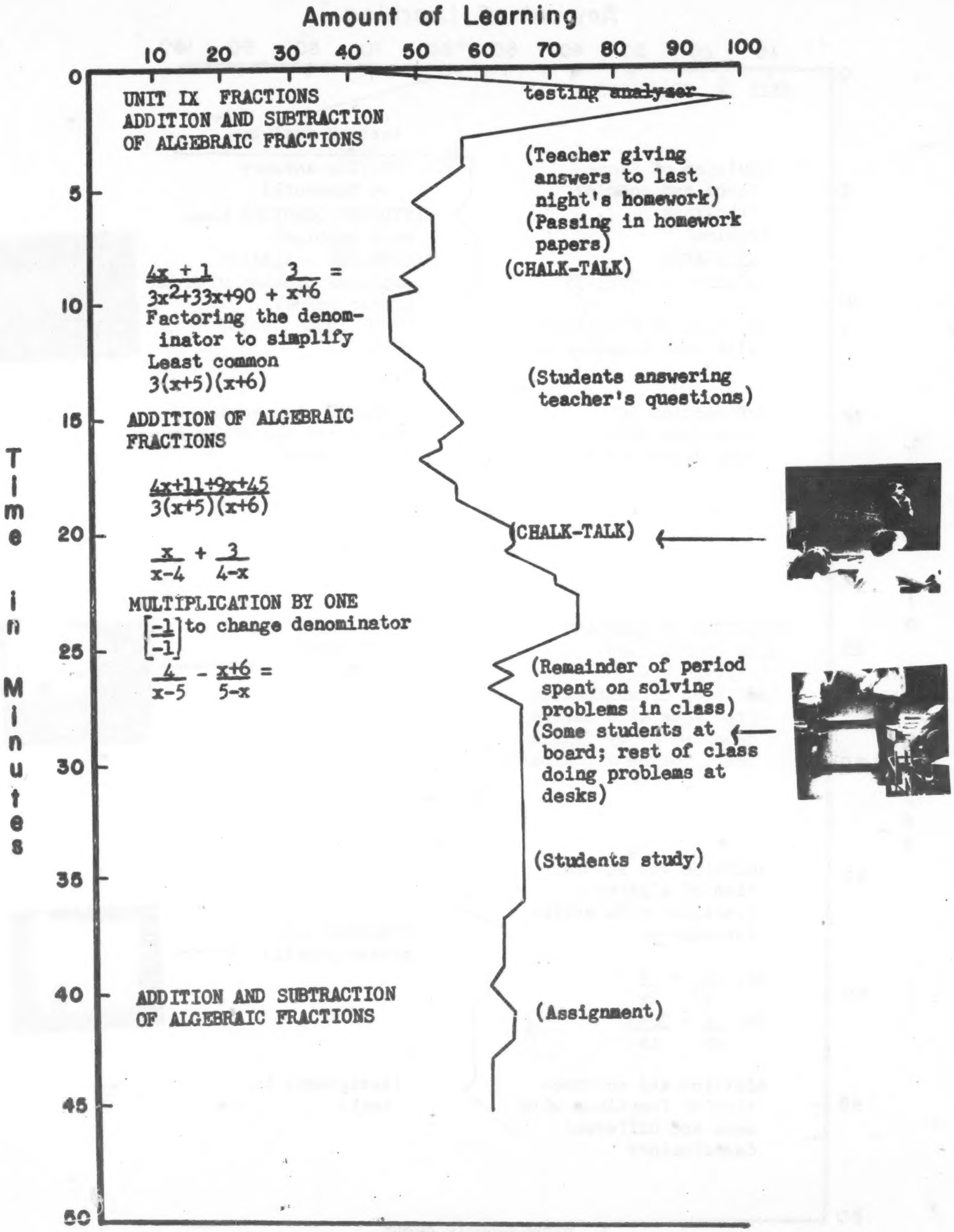

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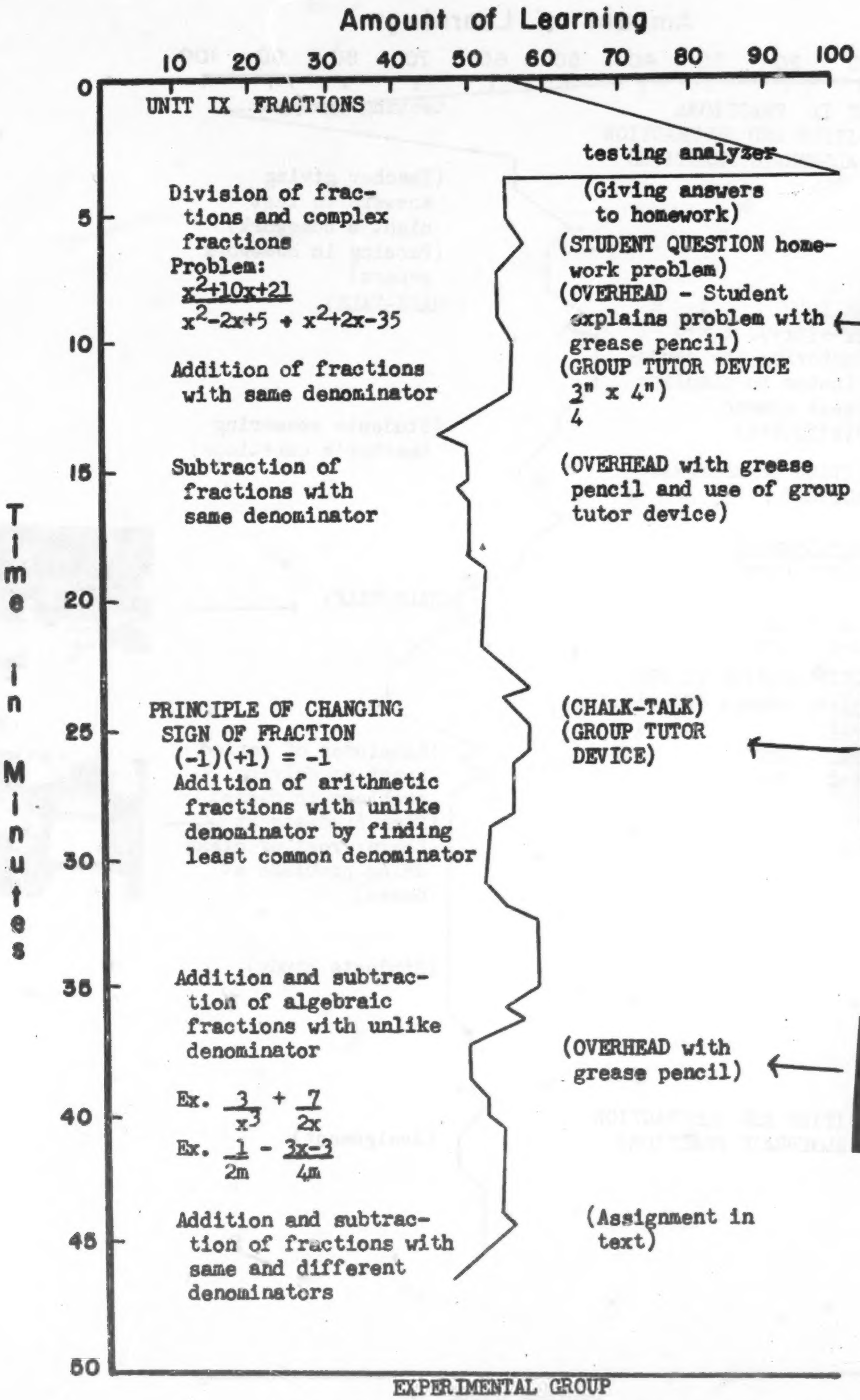

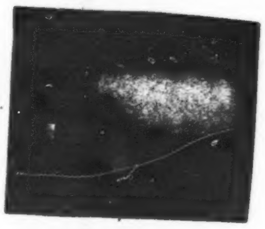

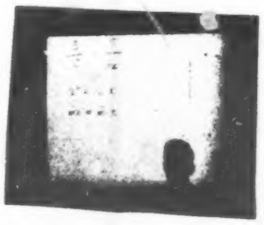

EXPERIMENTAL GROUP

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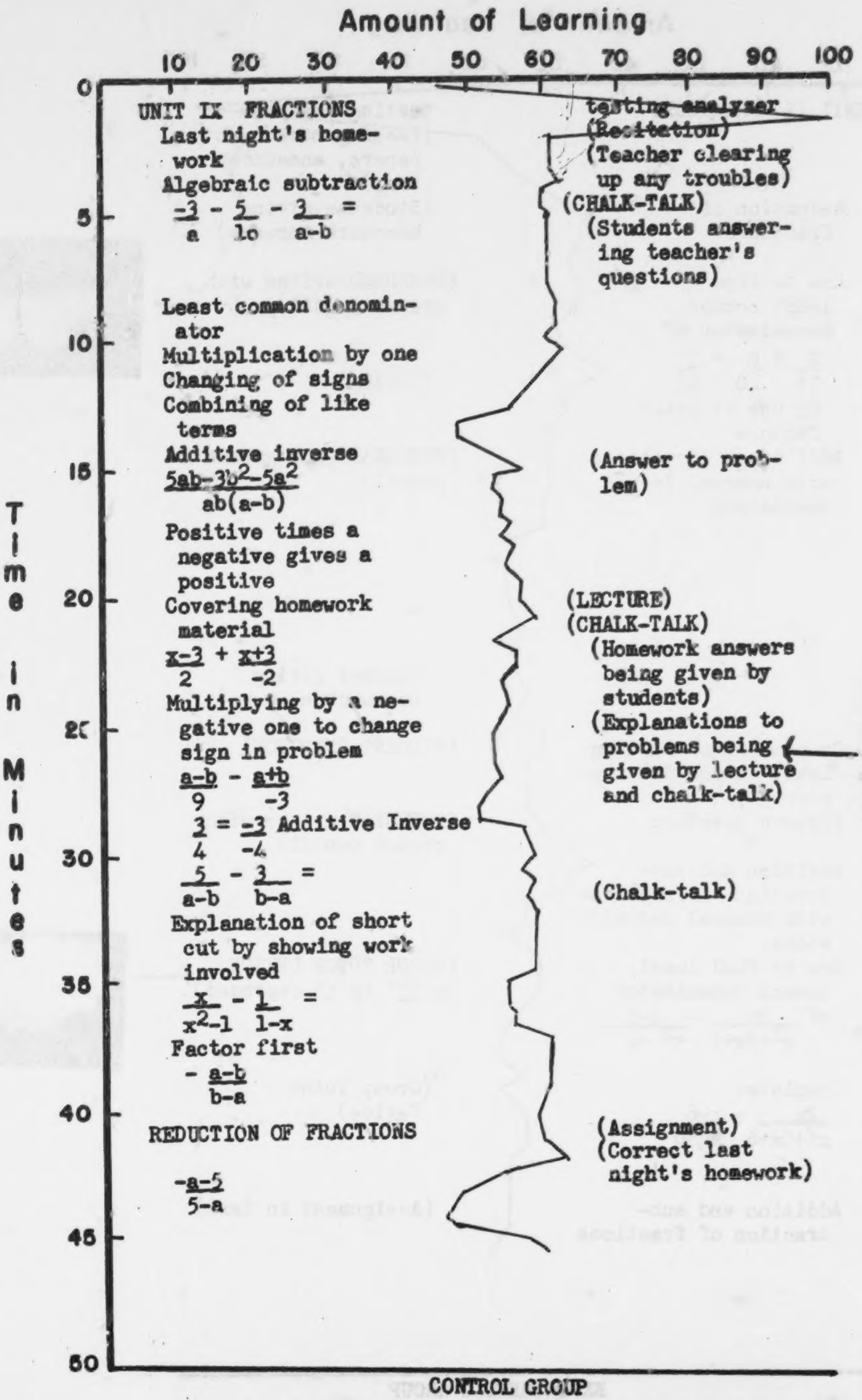

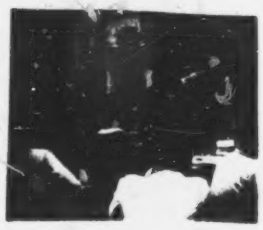

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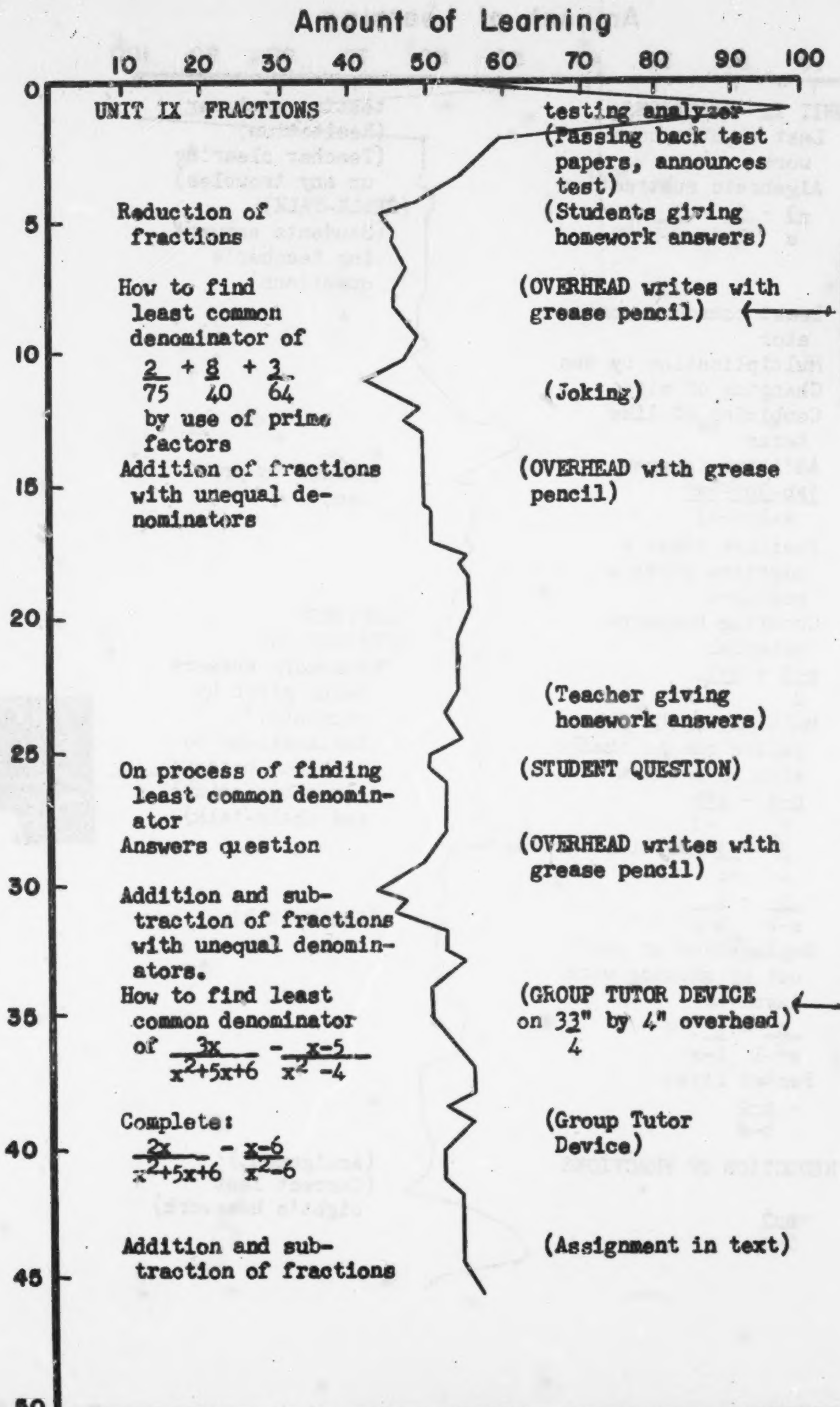

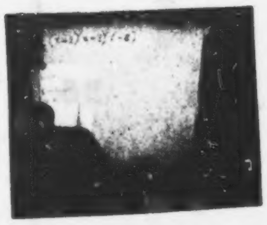

EXPERIMENTAL GROUP

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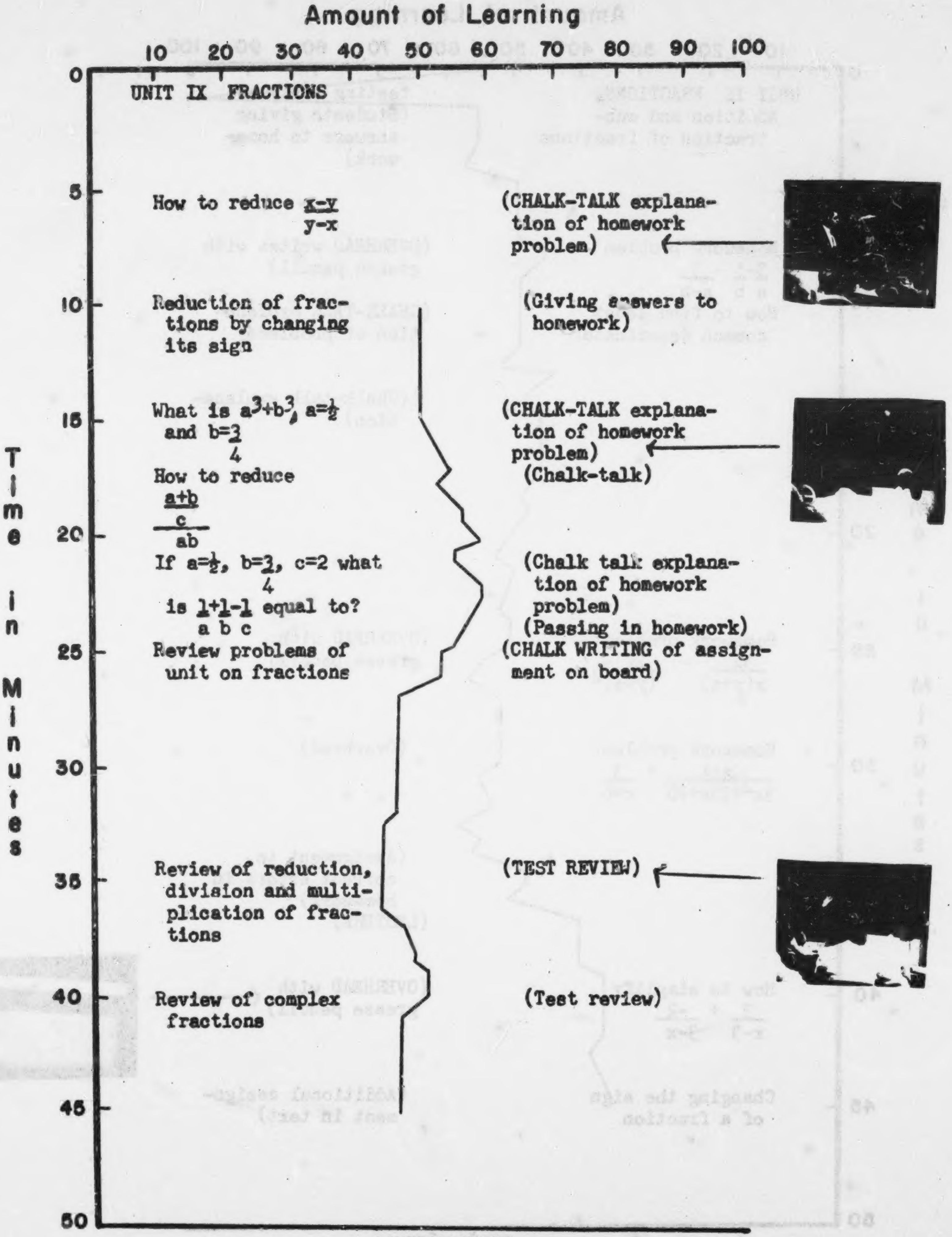

CONTROL GROUP

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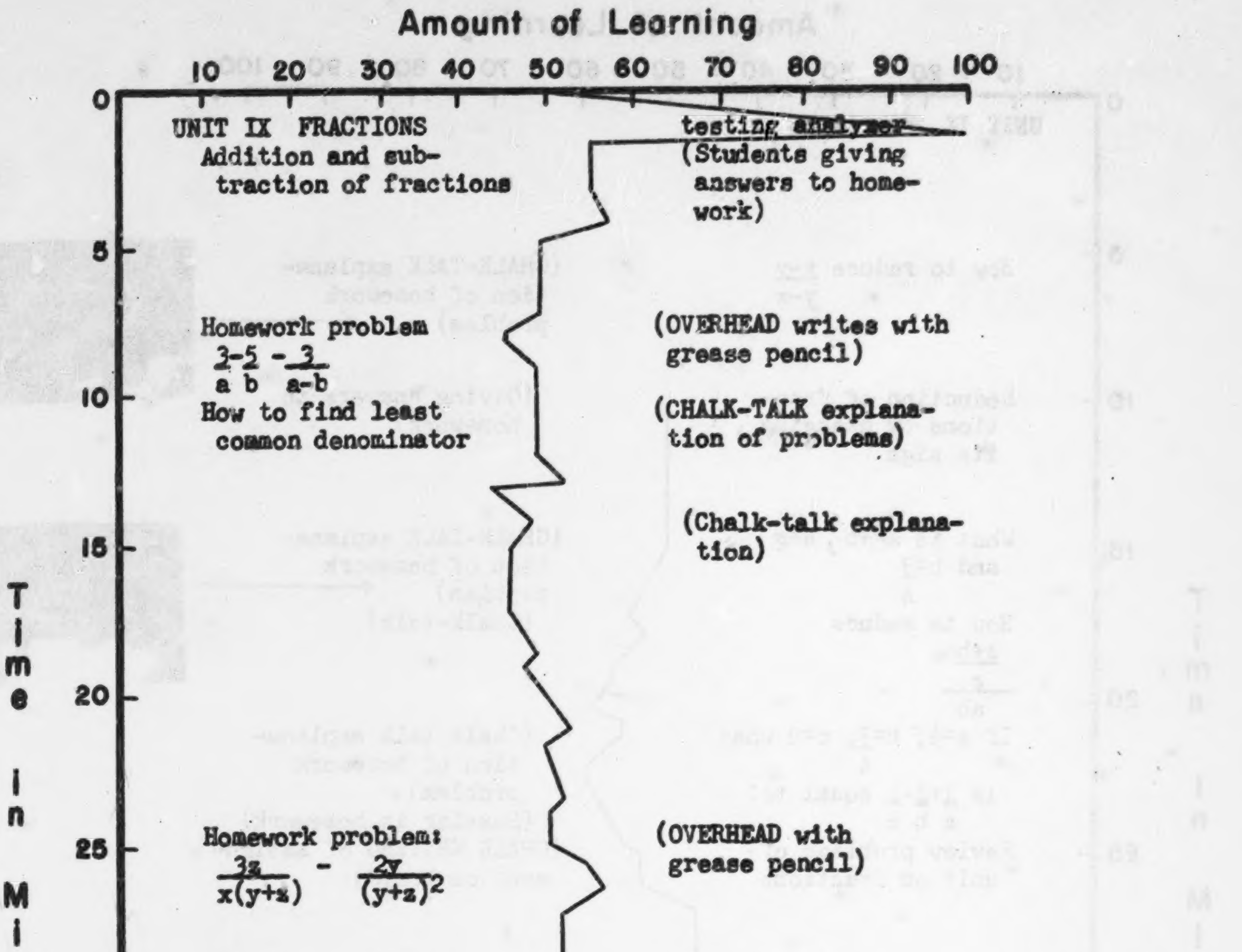

EXPERIMENTAL GROUP

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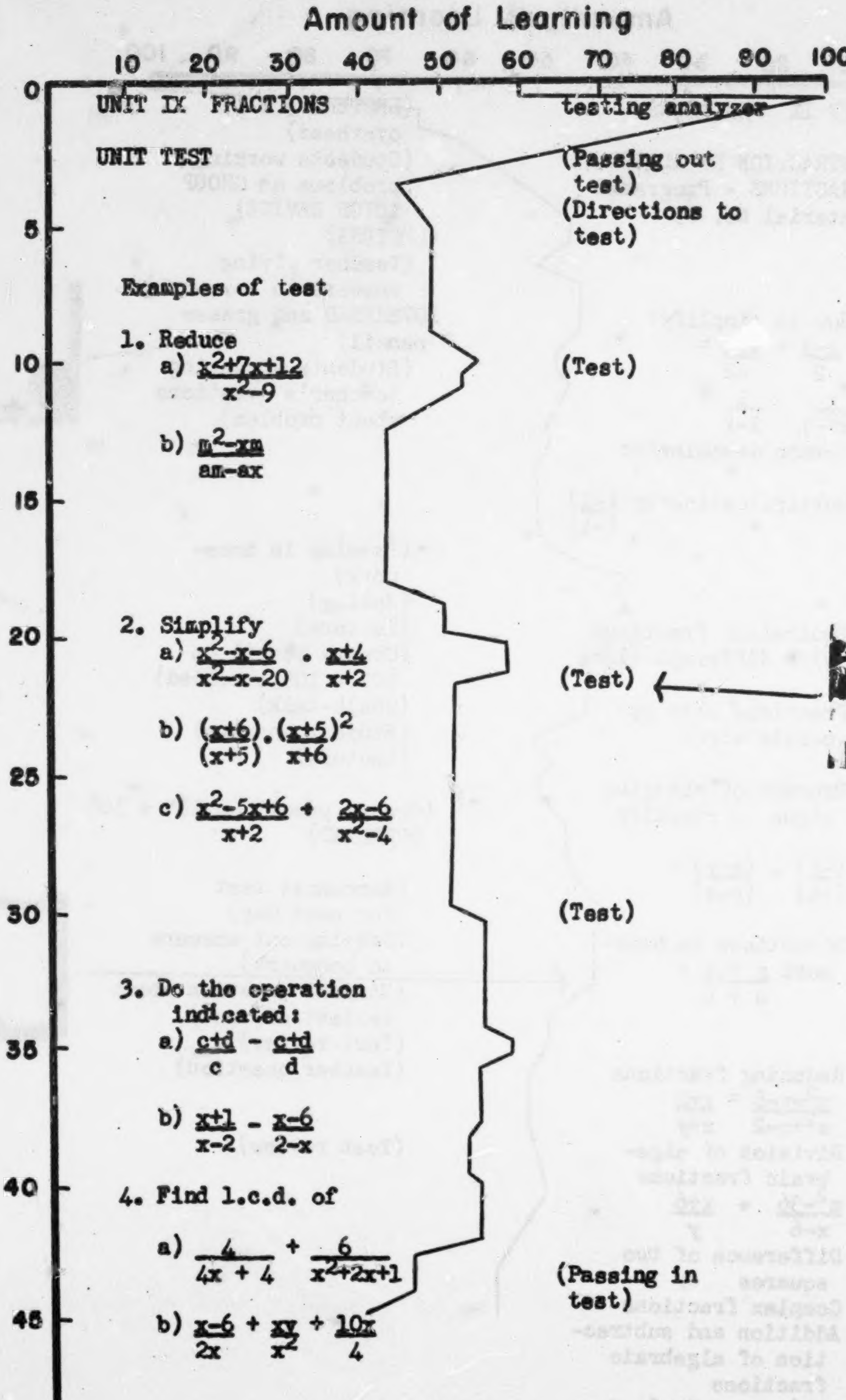


UNIT IX FRACTIONS

UNIT TEST

Examples of test

1. Reduce
   a) $\frac{x^2+7x+12}{x^2-9}$
   b) $\frac{m^2-xm}{am-ax}$

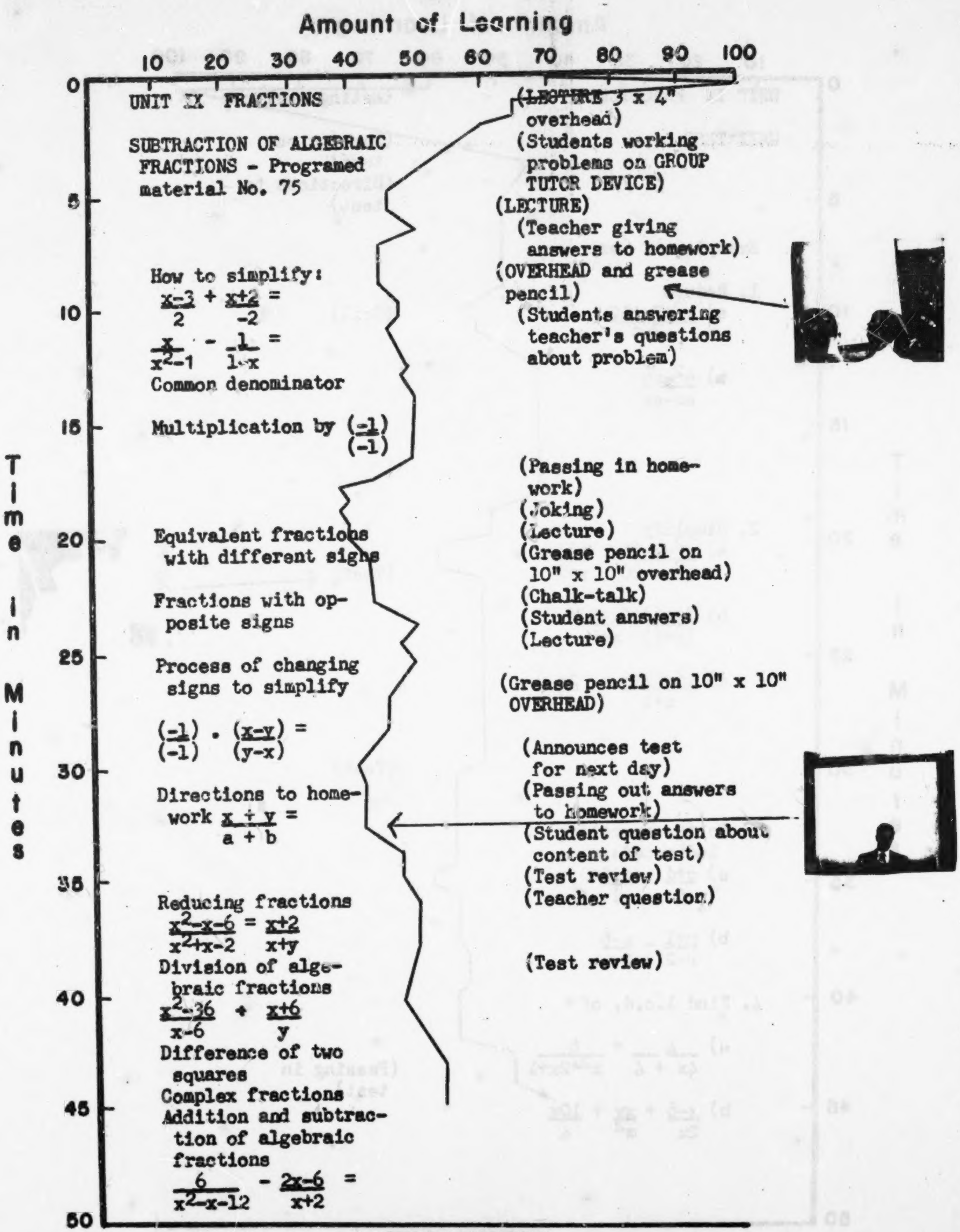
2. Simplify
   a) $\frac{x^2-x-6}{x^2-x-20} \cdot \frac{x+4}{x+2}$
   b) $\frac{(x+6)}{(x+5)} \cdot \frac{(x+5)^2}{x+6}$
   c) $\frac{x^2-5x+6}{x+2} \div \frac{2x-6}{x^2-4}$

3. Do the operation indicated:
   a) $\frac{c+d}{c} - \frac{c+d}{d}$
   b) $\frac{x+1}{x-2} - \frac{x-6}{2-x}$

4. Find l.c.d. of
   a) $\frac{4}{4x+4} + \frac{6}{x^2+2x+1}$
   b) $\frac{x-6}{2x} + \frac{xy}{x^2} + \frac{10x}{4}$

CONTROL GROUP

LEARNING PROFILE NUMBER 217



UNIT IX FRACTIONS

SUBTRACTION OF ALGEBRAIC FRACTIONS - Programed material No. 75

How to simplify:

$\frac{x-3}{2} + \frac{x+2}{-2} =$

$\frac{x}{x^2-1} - \frac{1}{1-x} =$

Common denominator

Multiplication by $\frac{-1}{-1}$

Equivalent fractions with different signs

Fractions with opposite signs

Process of changing signs to simplify

$\frac{-1}{-1} \cdot \frac{x-y}{y-x} =$

Directions to homework $\frac{x+y}{a+b} =$

Reducing fractions

$\frac{x^2-x-6}{x^2+x-2} = \frac{x+2}{x+y}$

Division of algebraic fractions

$\frac{x^2-36}{x-6} \div \frac{x+6}{y}$

Difference of two squares

Complex fractions

Addition and subtraction of algebraic fractions

$\frac{6}{x^2-x-12} - \frac{2x-6}{x+2} =$

(LECTURE 3 x 4" overhead)
(Students working problems on GROUP TUTOR DEVICE)
(LECTURE)
(Teacher giving answers to homework)
(OVERHEAD and grease pencil)
(Students answering teacher's questions about problem)

(Passing in homework)
(Joking)
(Lecture)
(Grease pencil on 10" x 10" overhead)
(Chalk-talk)
(Student answers)
(Lecture)

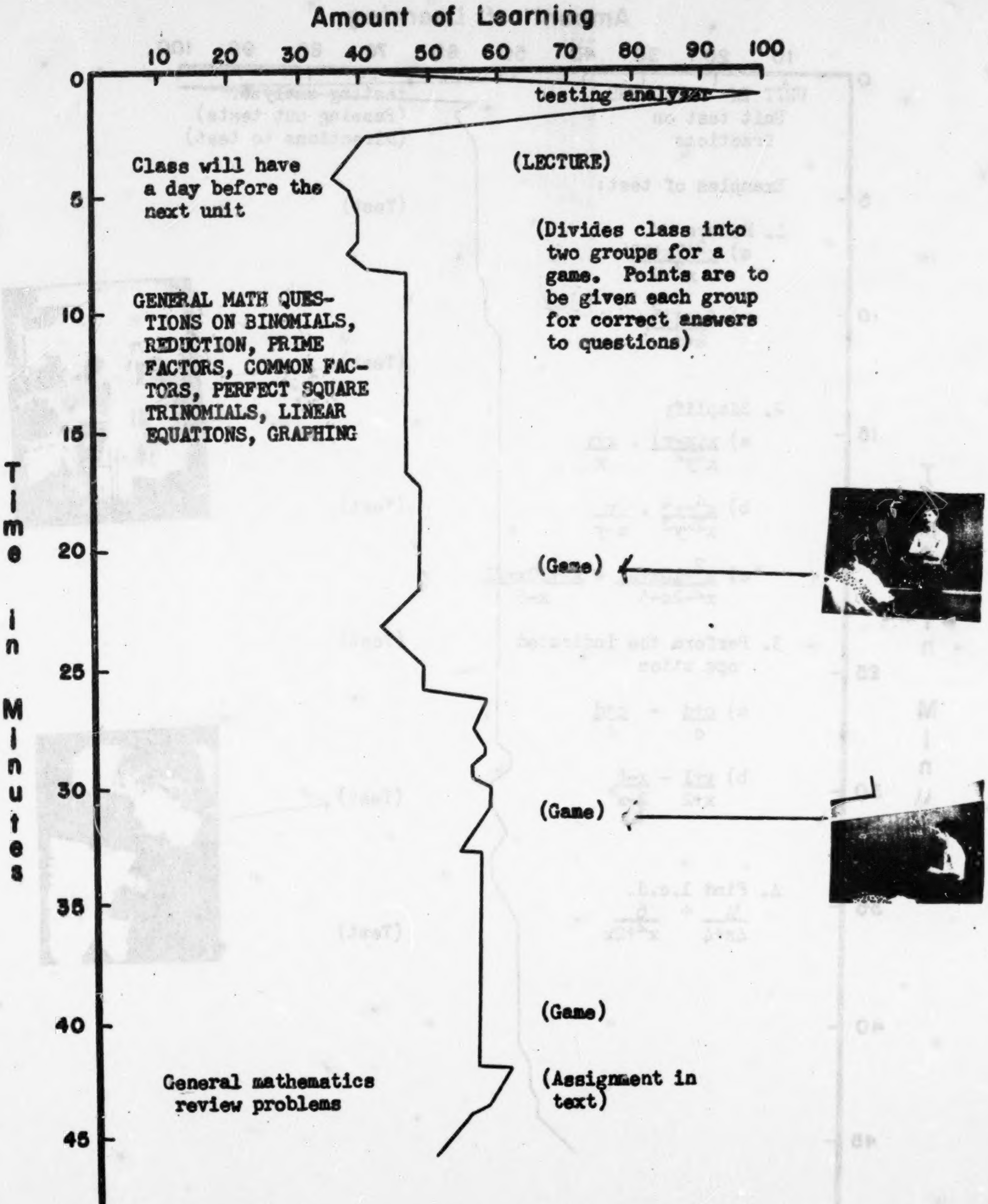
(Grease pencil on 10" x 10" OVERHEAD)

(Announces test for next day)
(Passing out answers to homework)
(Student question about content of test)
(Test review)
(Teacher question)

(Test review)

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 218



CONTROL GROUP

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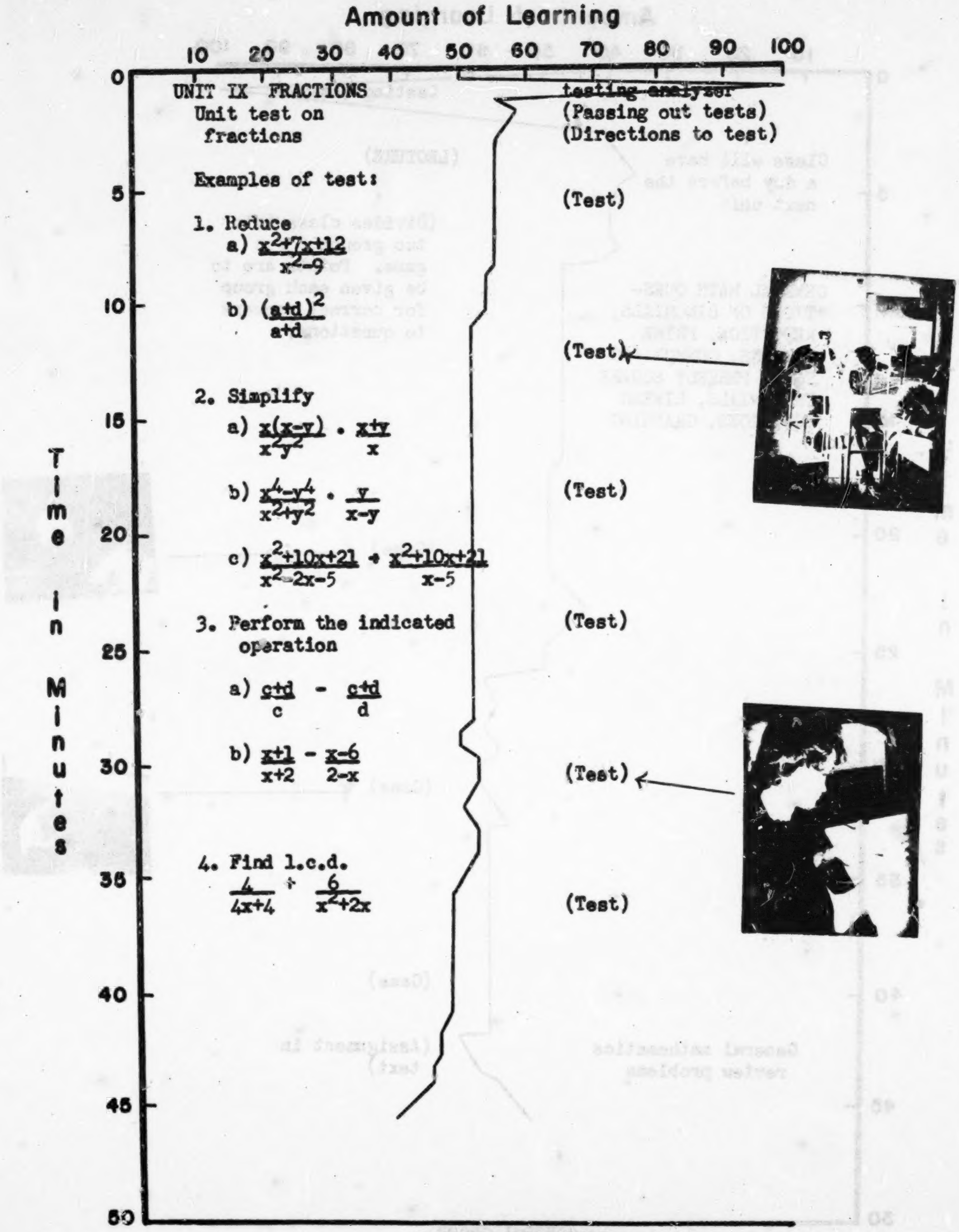


UNIT IX FRACTIONS

Unit test on fractions

Examples of test:

1. Reduce
   a) $\frac{x^2+7x+12}{x^2-9}$
   b) $\frac{(a+d)^2}{a+d}$

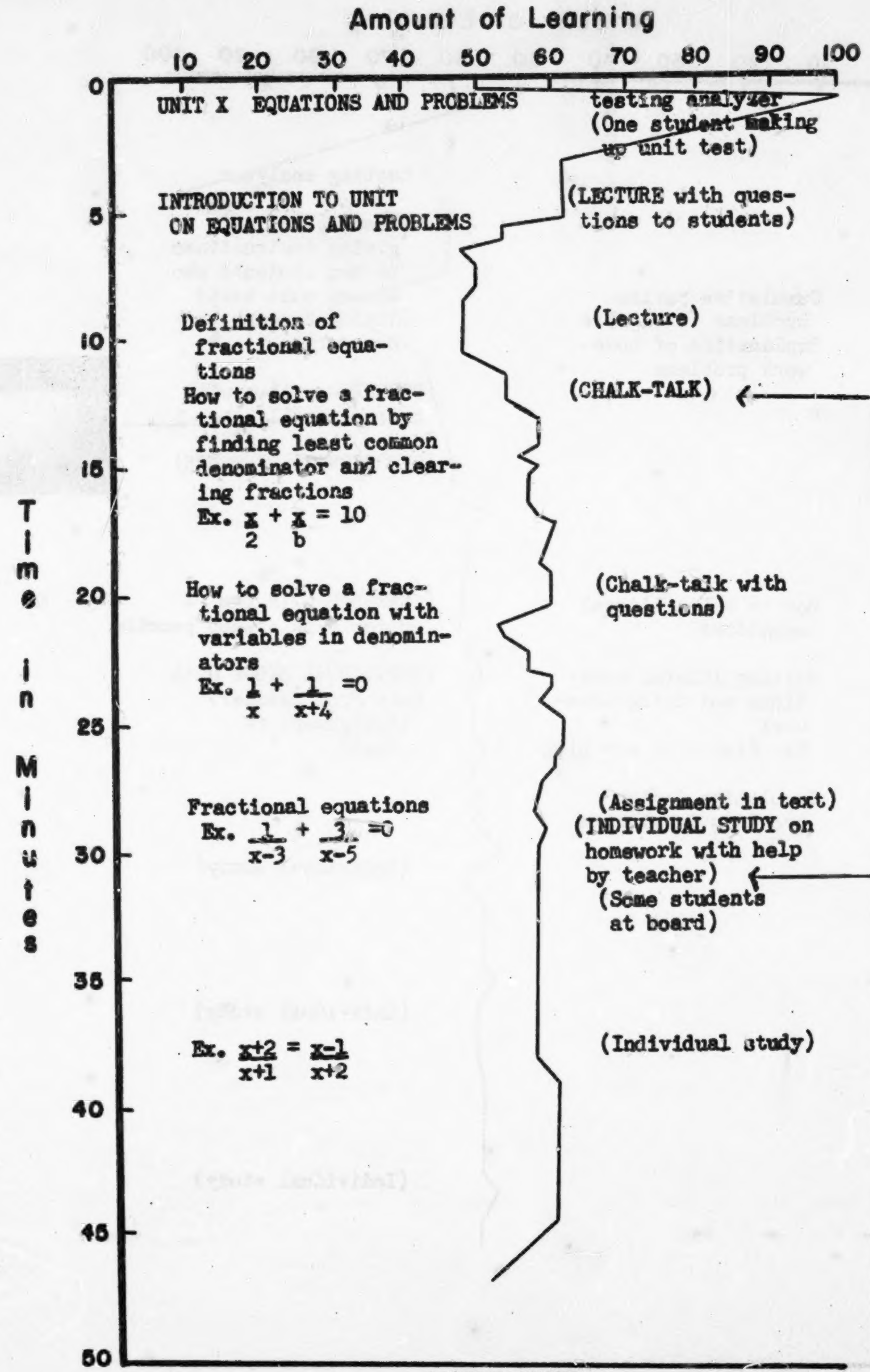
2. Simplify
   a) $\frac{x(x-y)}{x^2y^2} \cdot \frac{x+y}{x}$
   b) $\frac{x^4-y^4}{x^2+y^2} \cdot \frac{y}{x-y}$
   c) $\frac{x^2+10x+21}{x^2-2x-5} \div \frac{x^2+10x+21}{x-5}$

3. Perform the indicated operation
   a) $\frac{c+d}{c} - \frac{c+d}{d}$
   b) $\frac{x+1}{x+2} - \frac{x-6}{2-x}$

4. Find l.c.d.
   $\frac{4}{4x+4} + \frac{6}{x^2+2x}$

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 220



CONTROL GROUP

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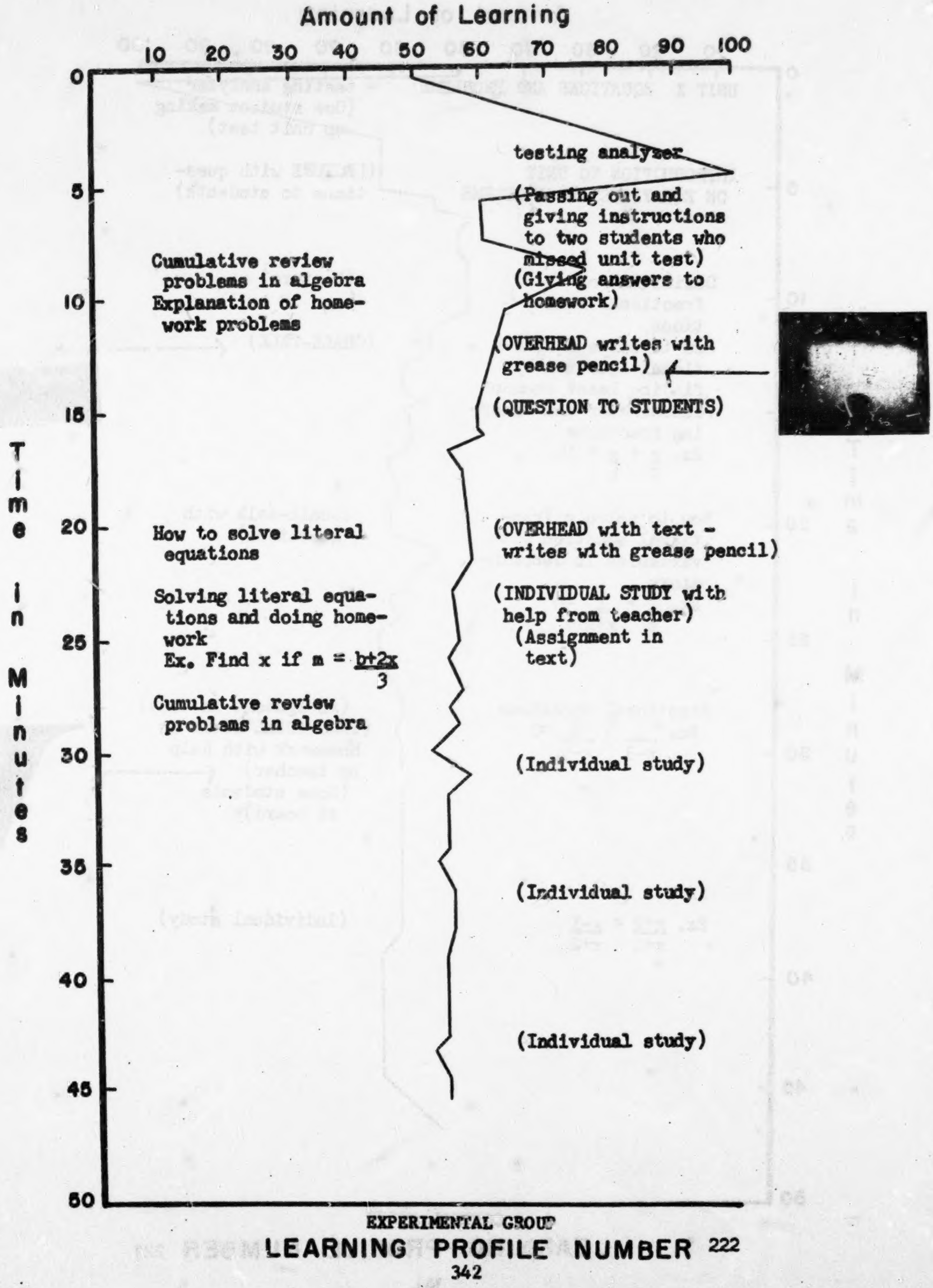

EXPERIMENTAL GROUP

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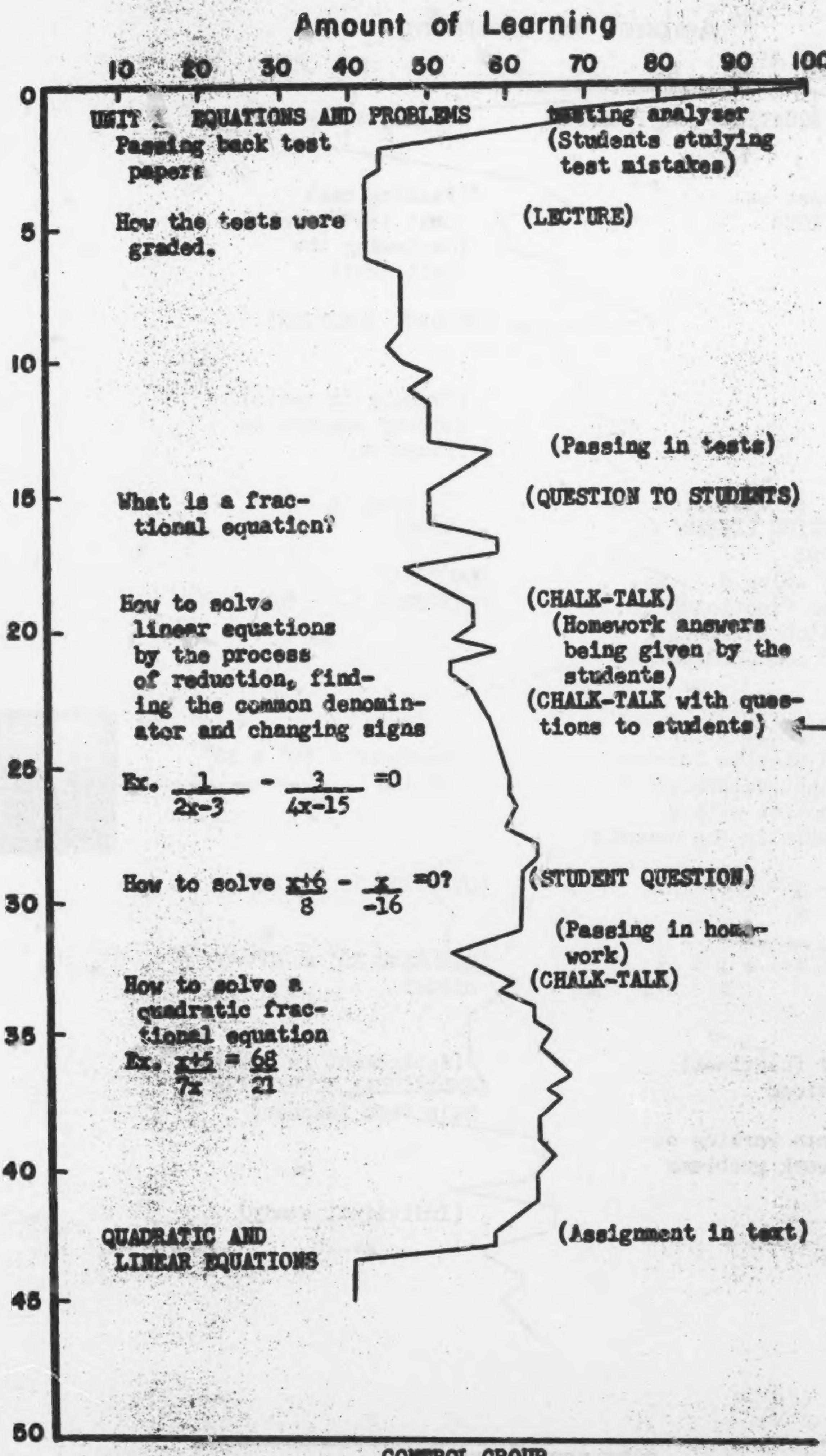

CONTROL GROUP

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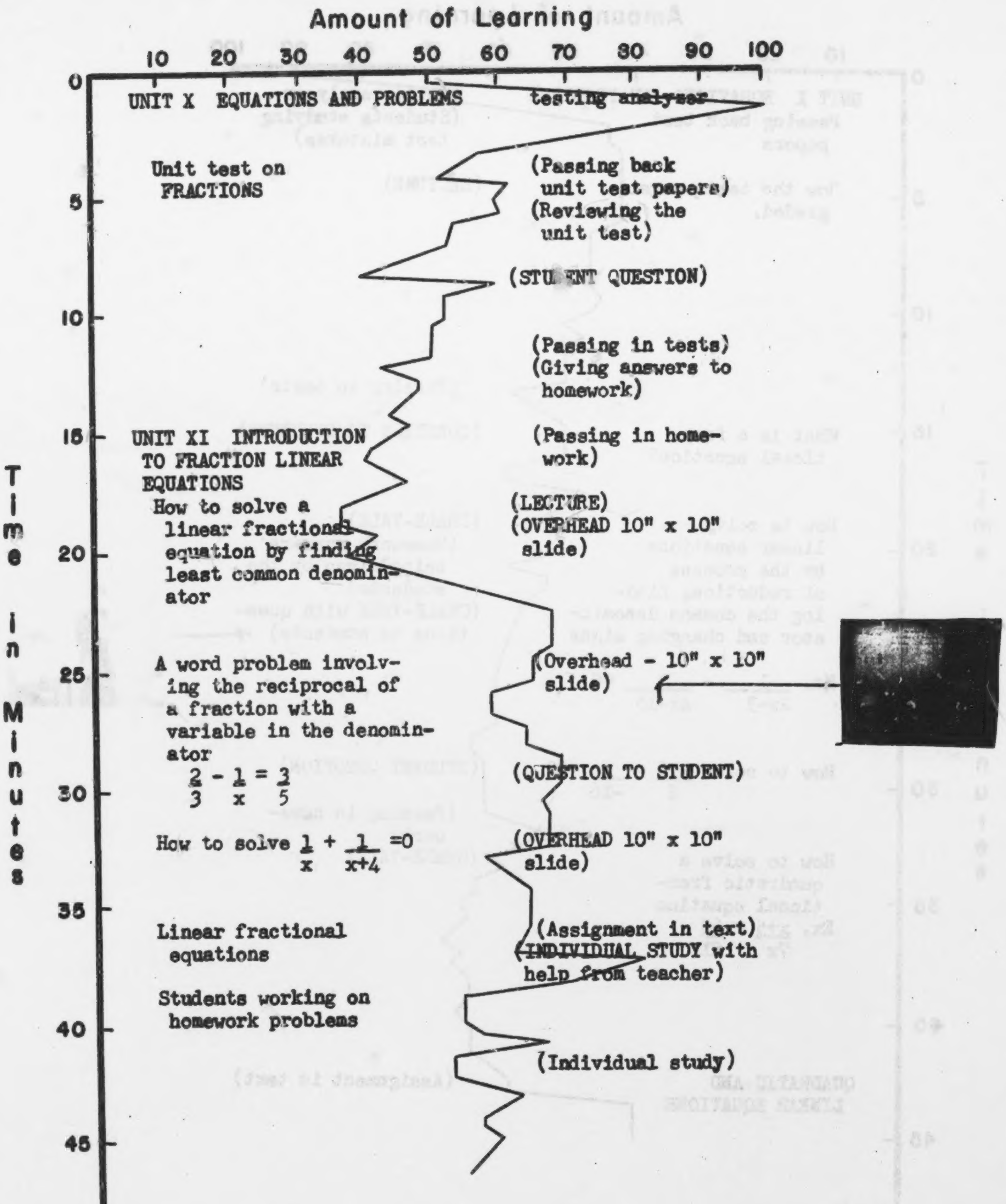

EXPERIMENTAL GROUP

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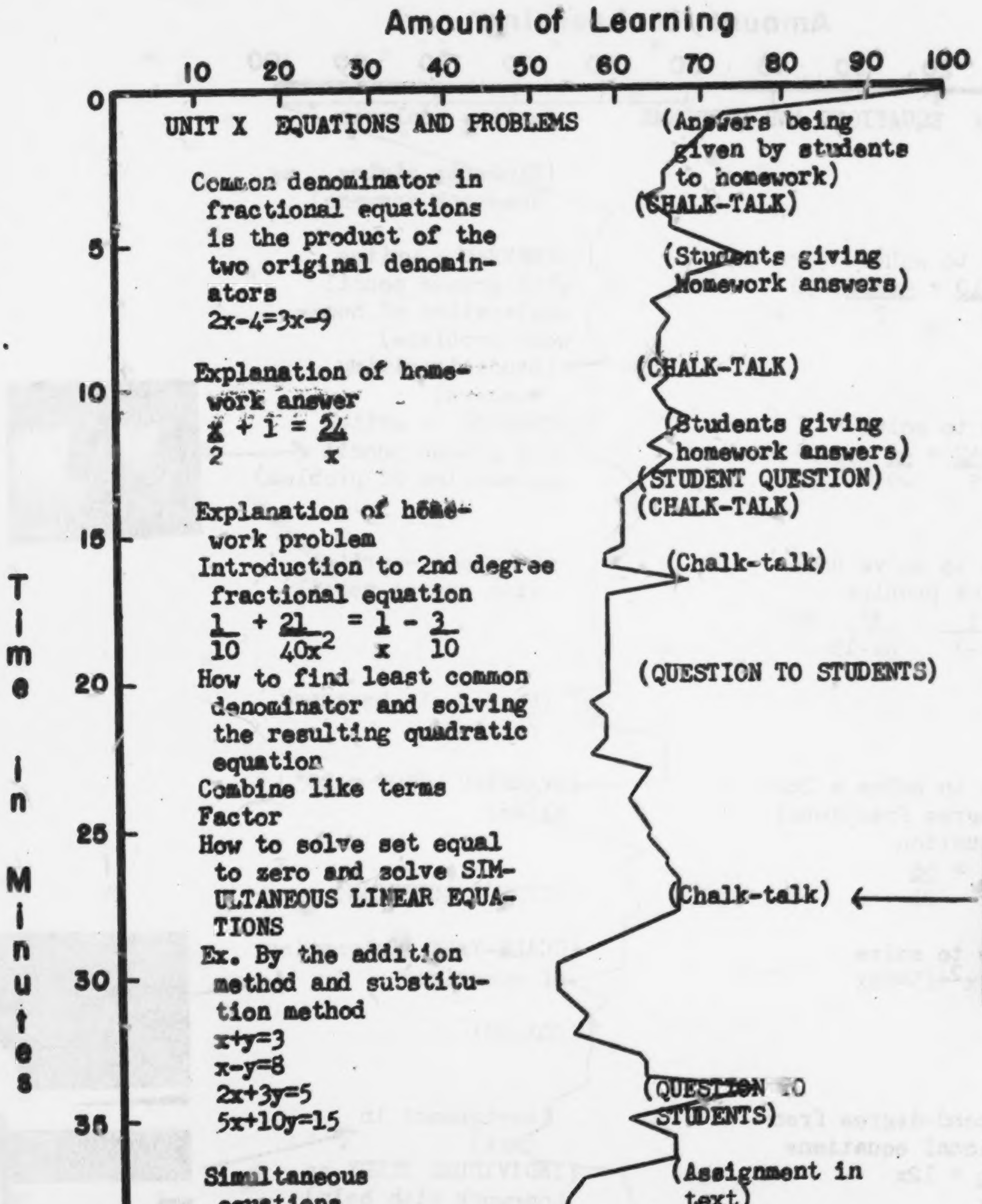

CONTROL GROUP

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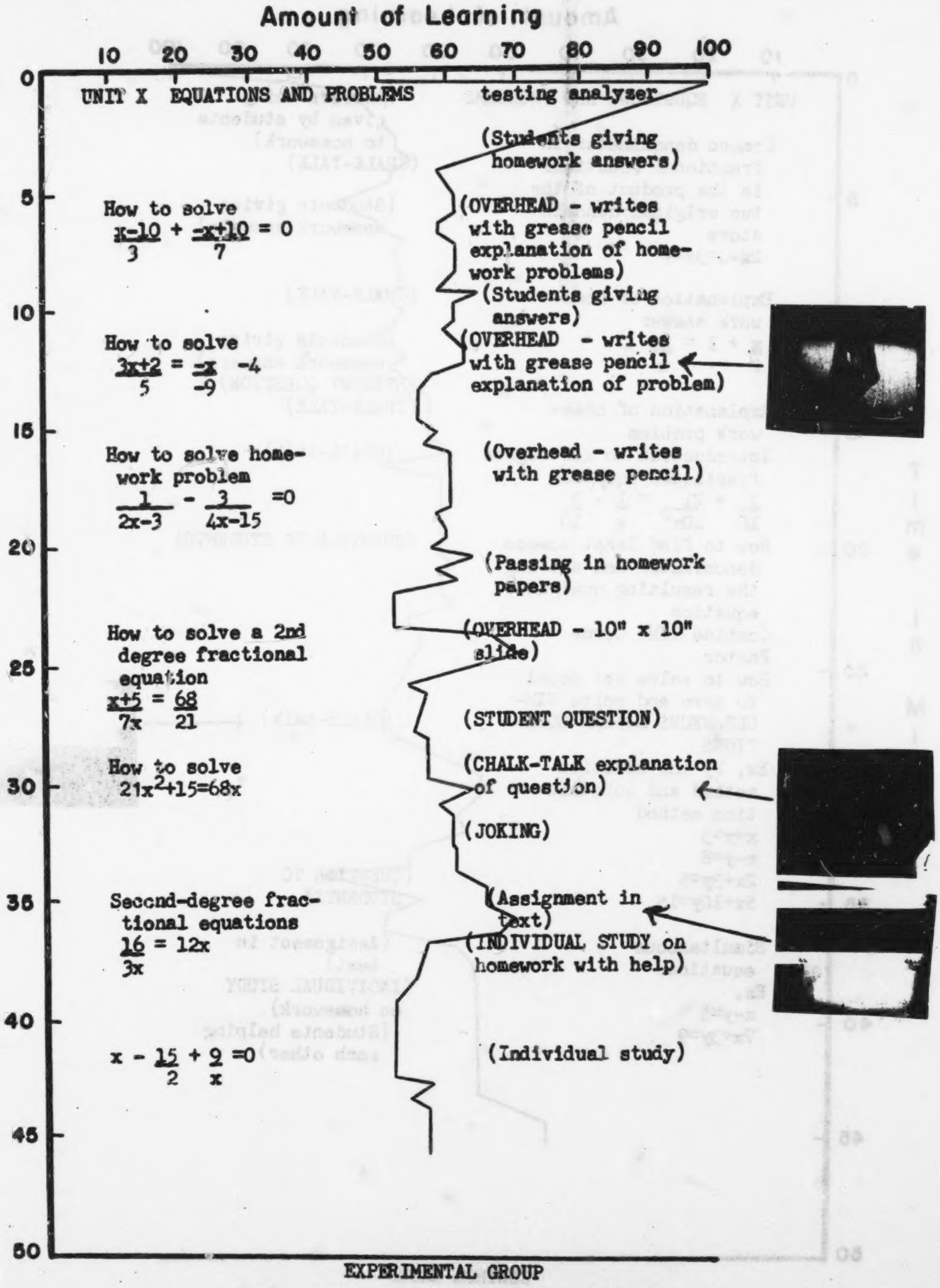

EXPERIMENTAL GROUP

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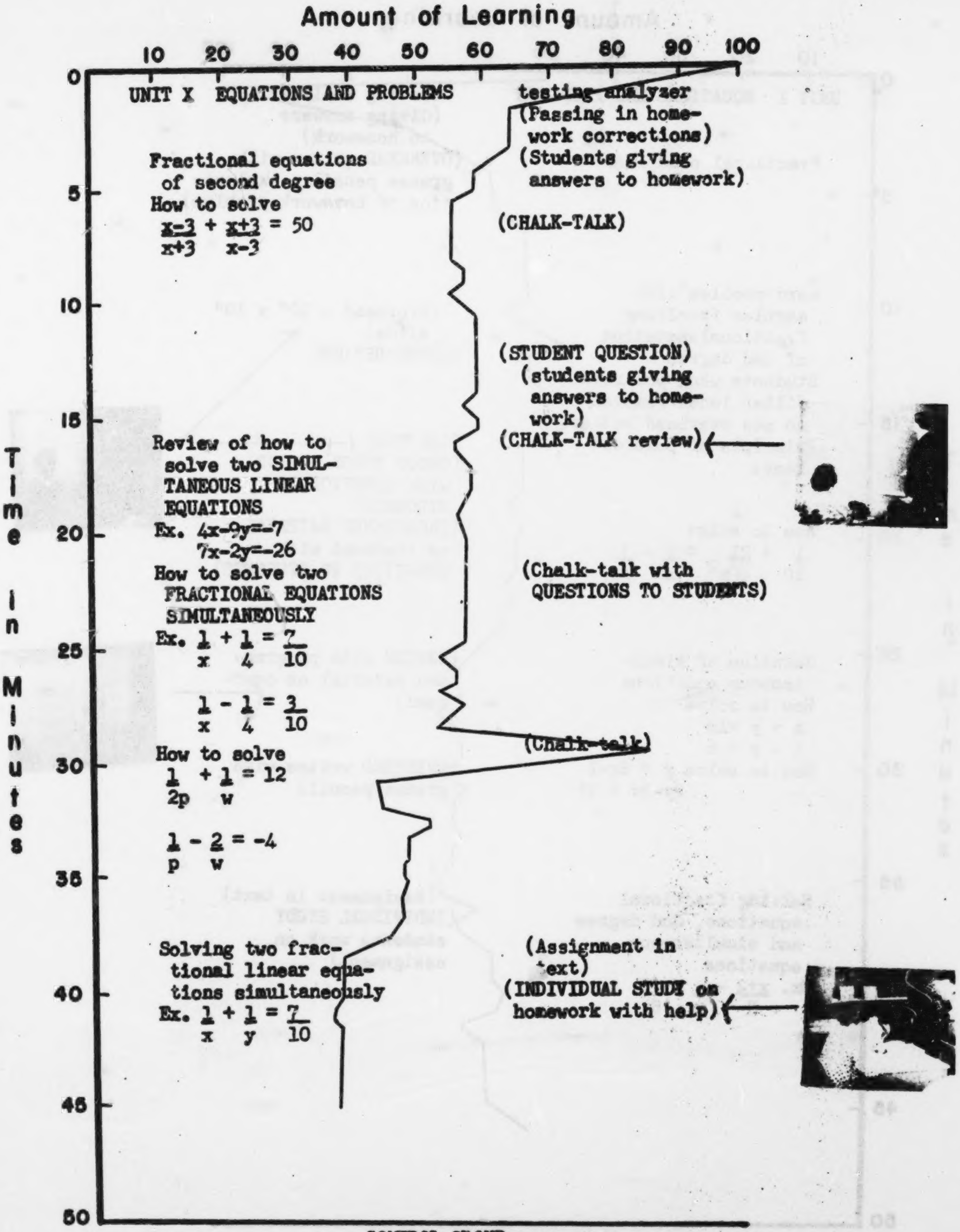

CONTROL GROUP

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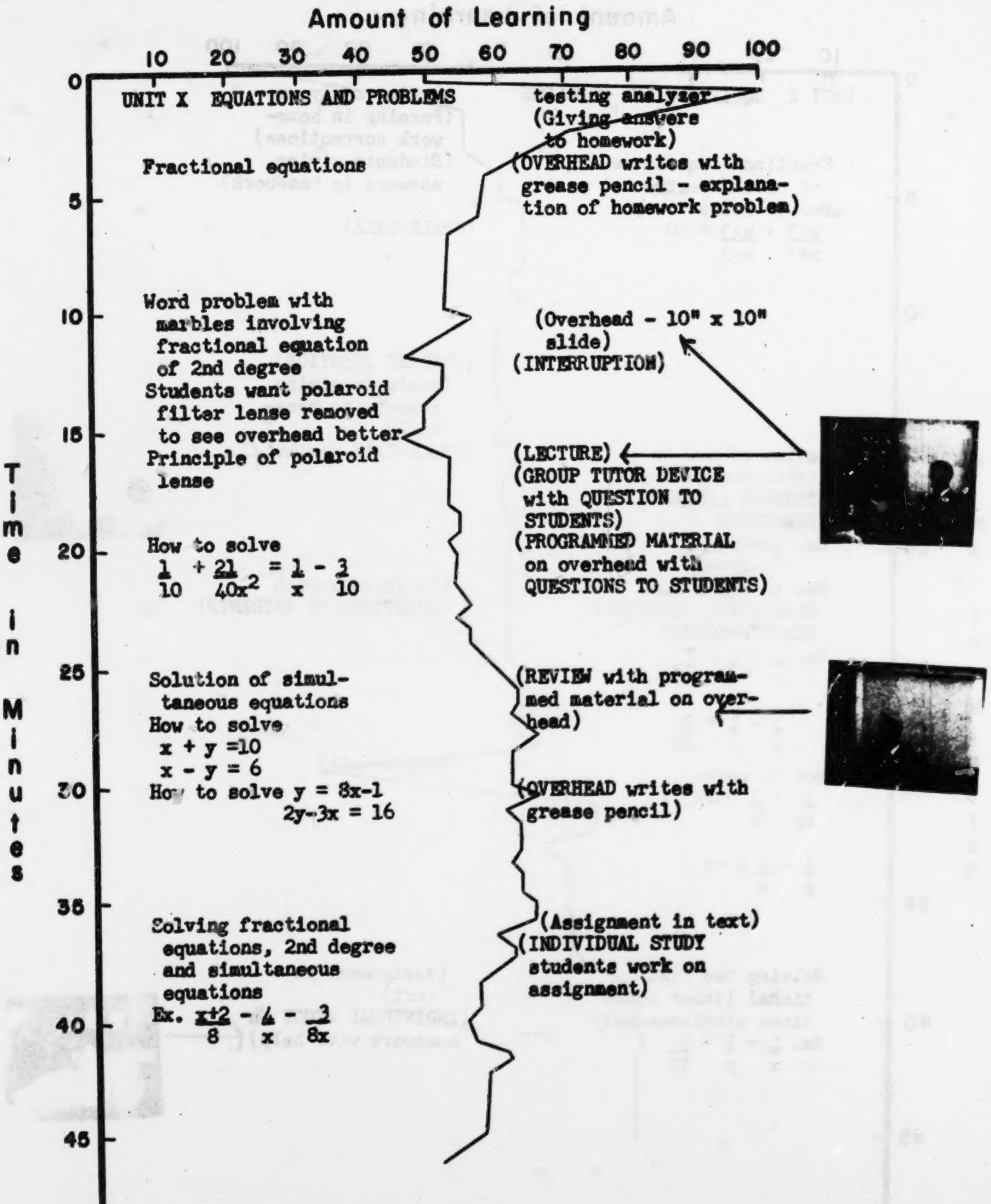

EXPERIMENTAL GROUP

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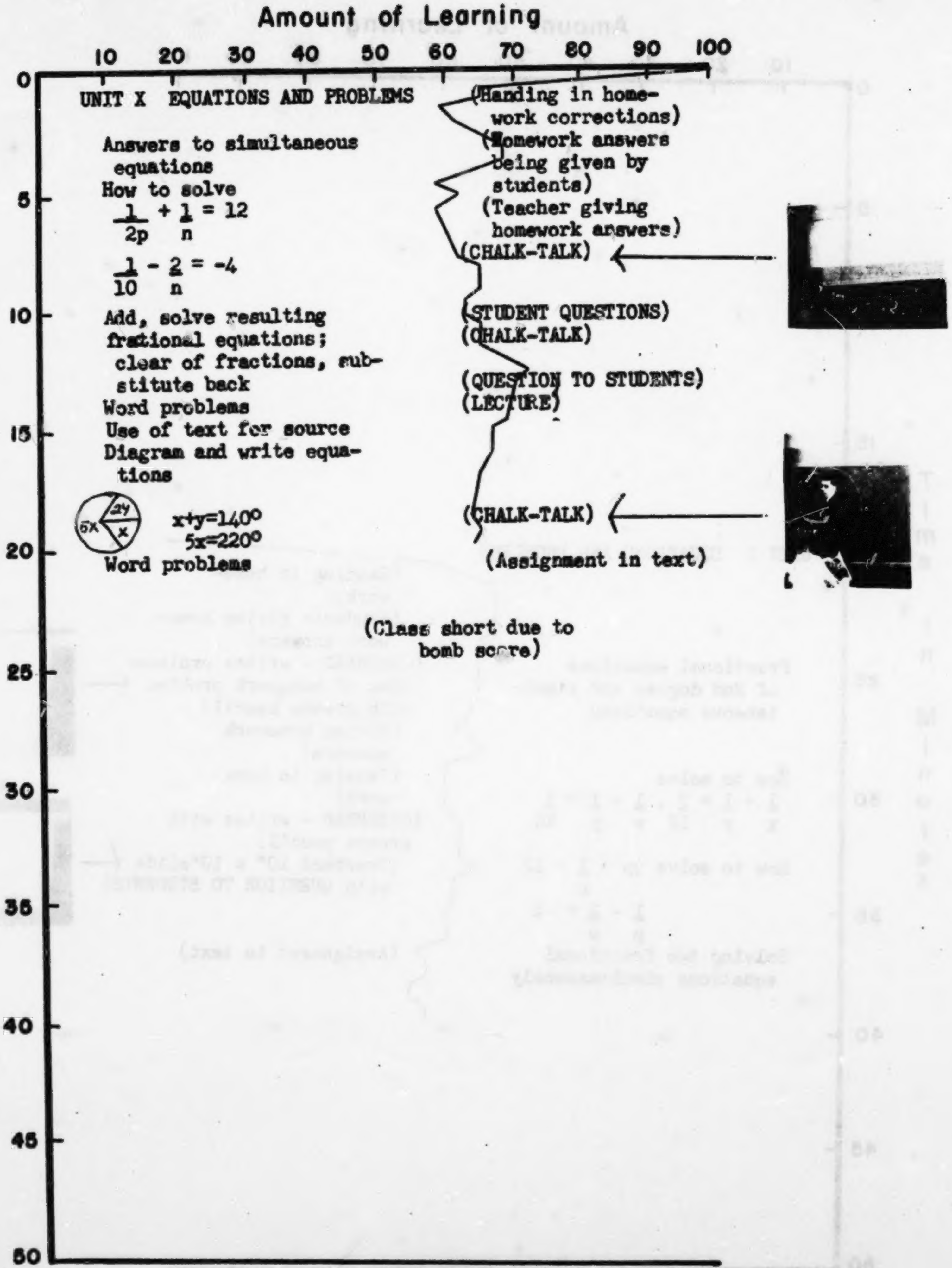

CONTROL GROUP

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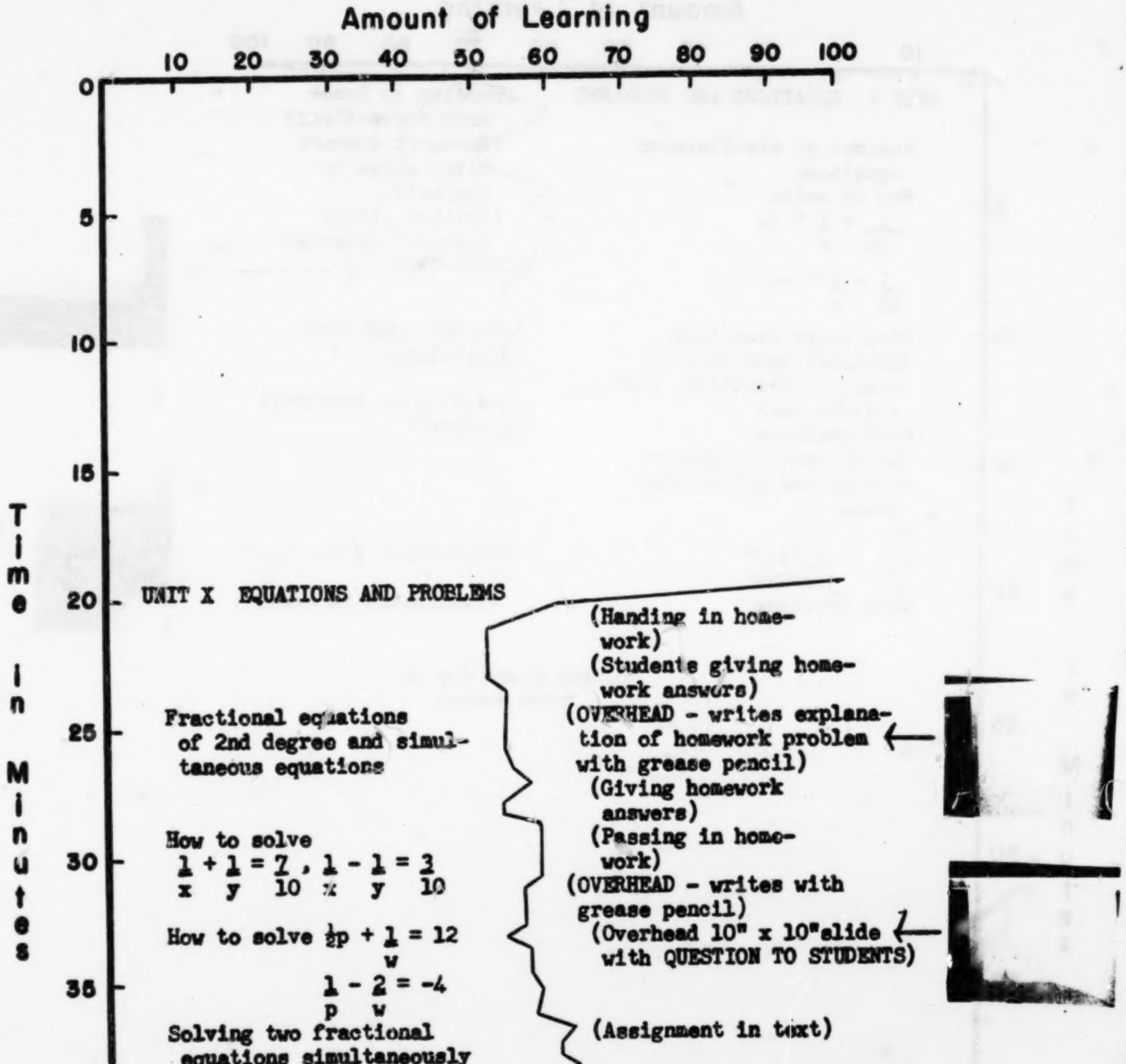

EXPERIMENTAL GROUP

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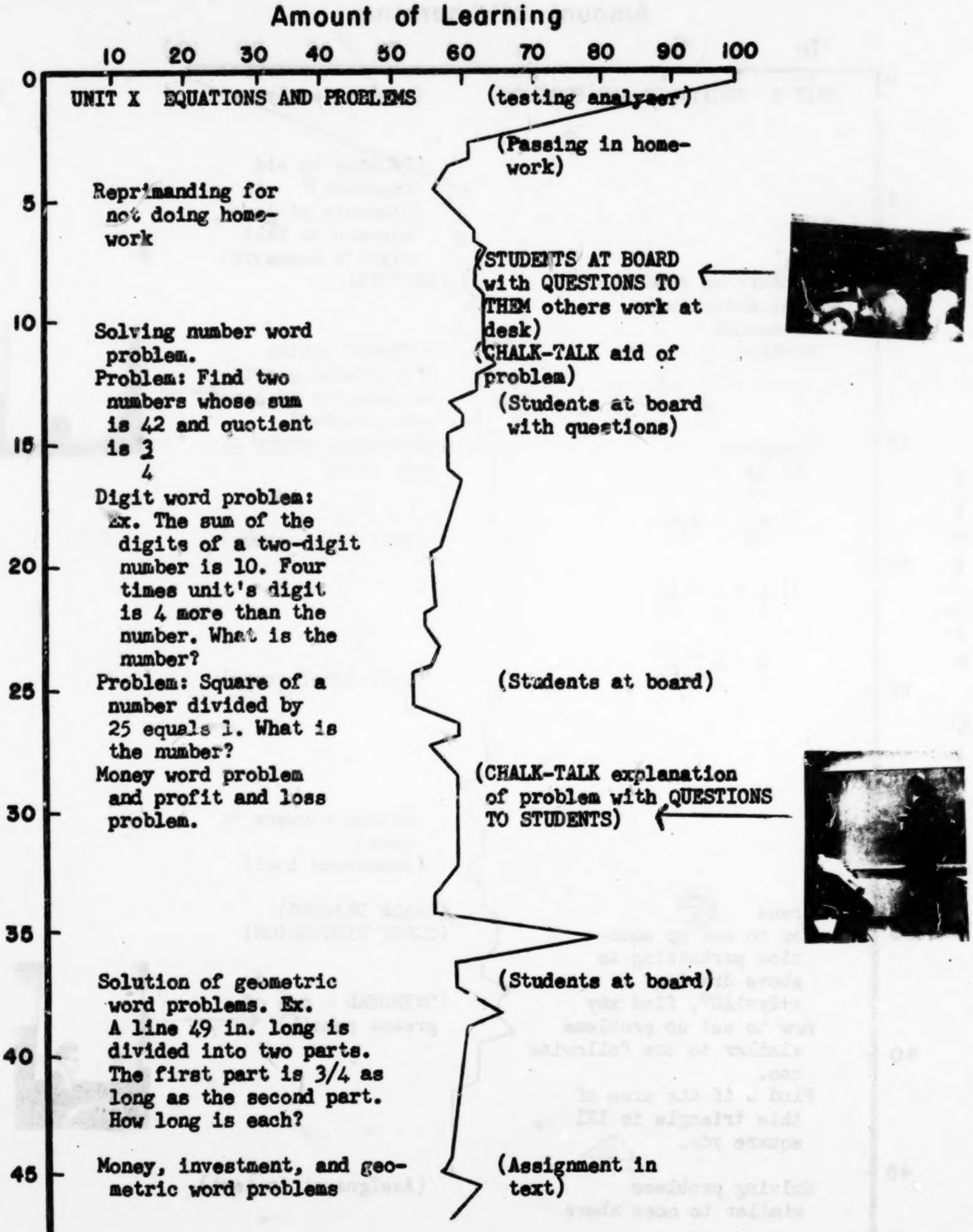

CONTROL GROUP

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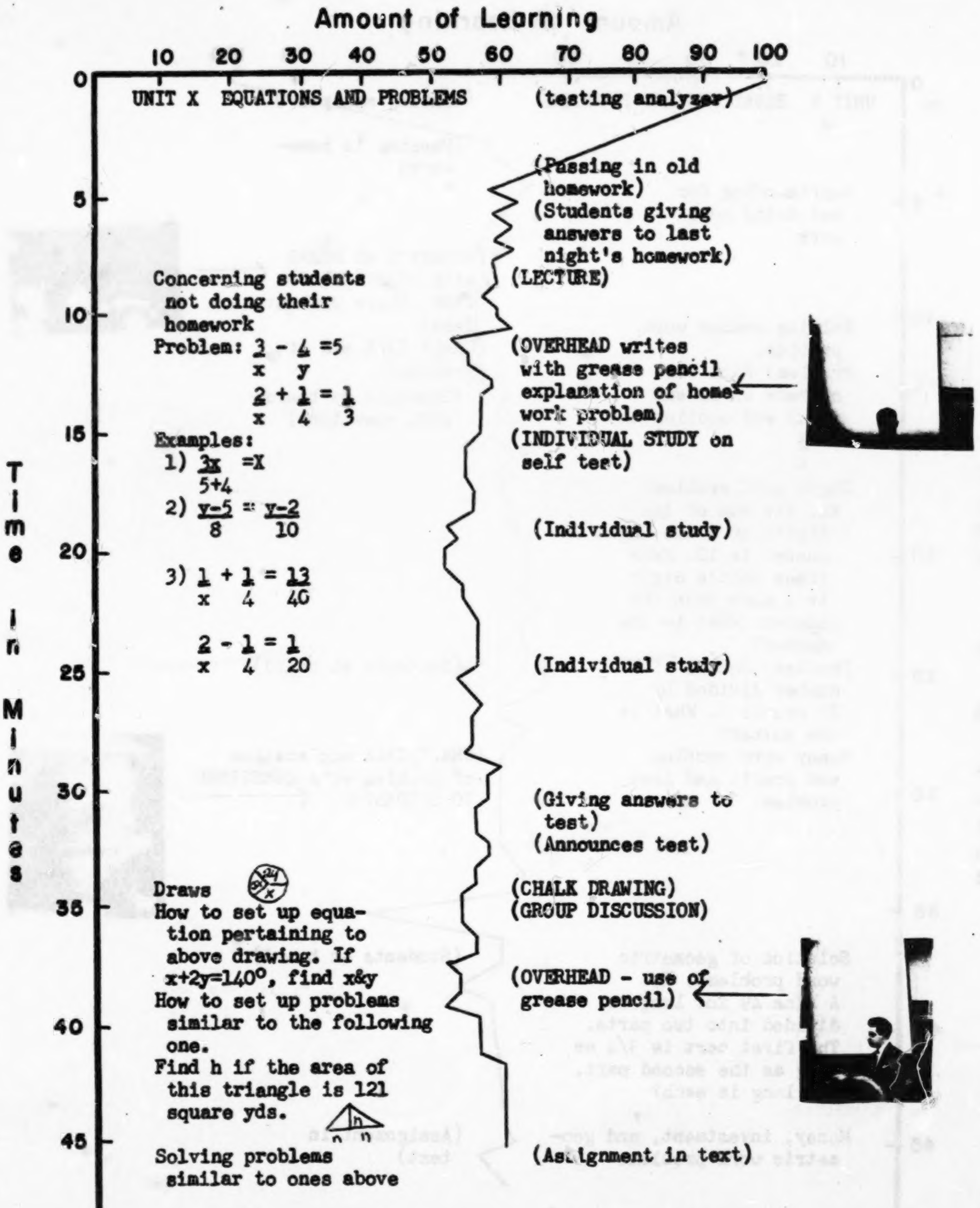


UNIT X EQUATIONS AND PROBLEMS

(testing analyzer)

(Passing in old homework)

(Students giving answers to last night's homework)

(LECTURE)

Concerning students not doing their homework

Problem: $\frac{3}{x} - \frac{4}{y} = 5$

$\frac{2}{x} + \frac{1}{4} = \frac{1}{3}$

(OVERHEAD writes with grease pencil explanation of homework problem)

Examples:

1) $\frac{3x}{5+4} = X$

2) $\frac{y-5}{8} = \frac{y-2}{10}$

3) $\frac{1}{x} + \frac{1}{4} = \frac{13}{40}$

$\frac{2}{x} - \frac{1}{4} = \frac{1}{20}$

(INDIVIDUAL STUDY on self test)

(Individual study)

(Individual study)

(Giving answers to test)

(Announces test)

Draws

How to set up equation pertaining to above drawing. If $x+2y=140^\circ$, find x&y

(CHALK DRAWING)

(GROUP DISCUSSION)

How to set up problems similar to the following one.

(OVERHEAD - use of grease pencil)

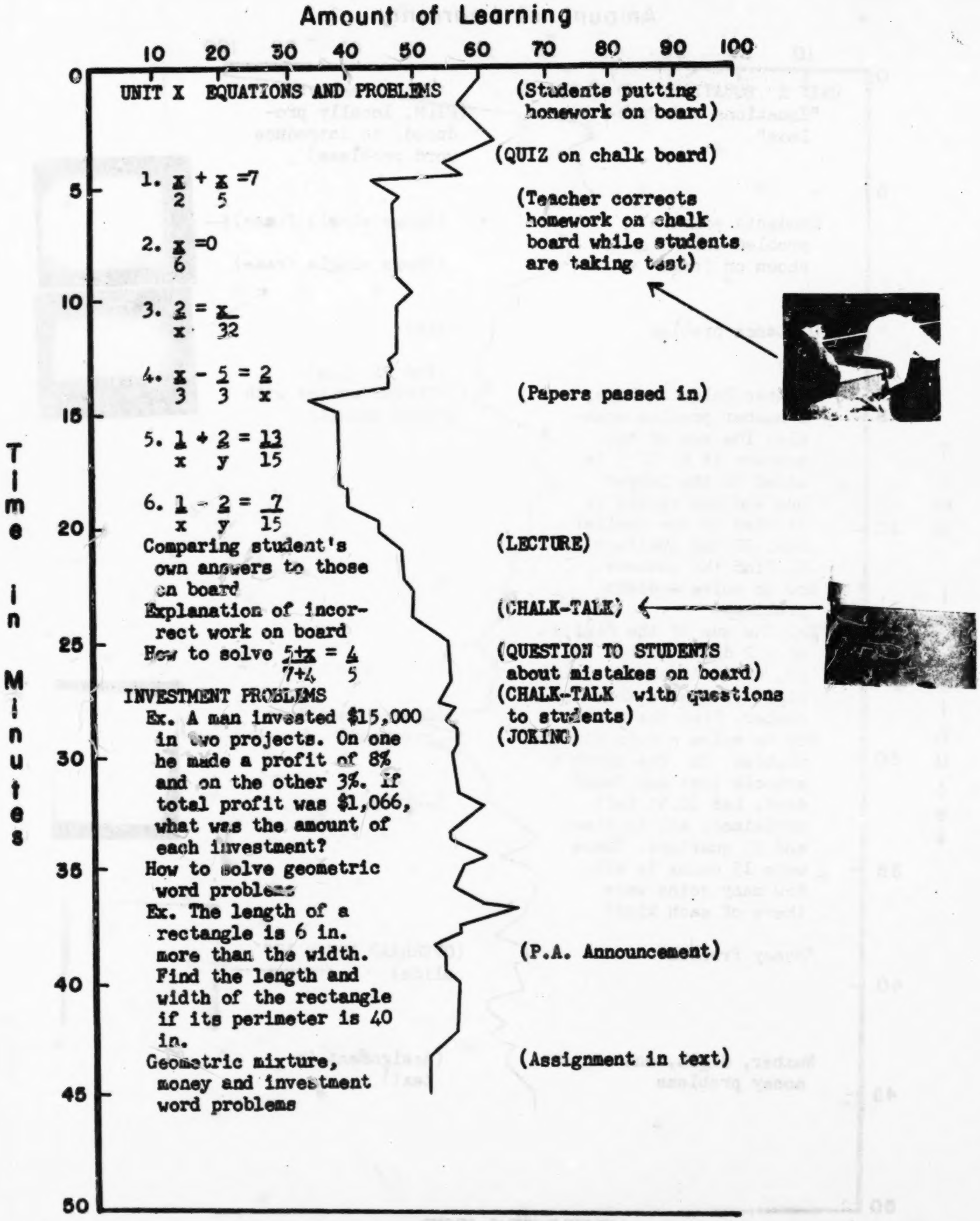
Find h if the area of this triangle is 121 square yds.

Solving problems similar to ones above

(Assignment in text)

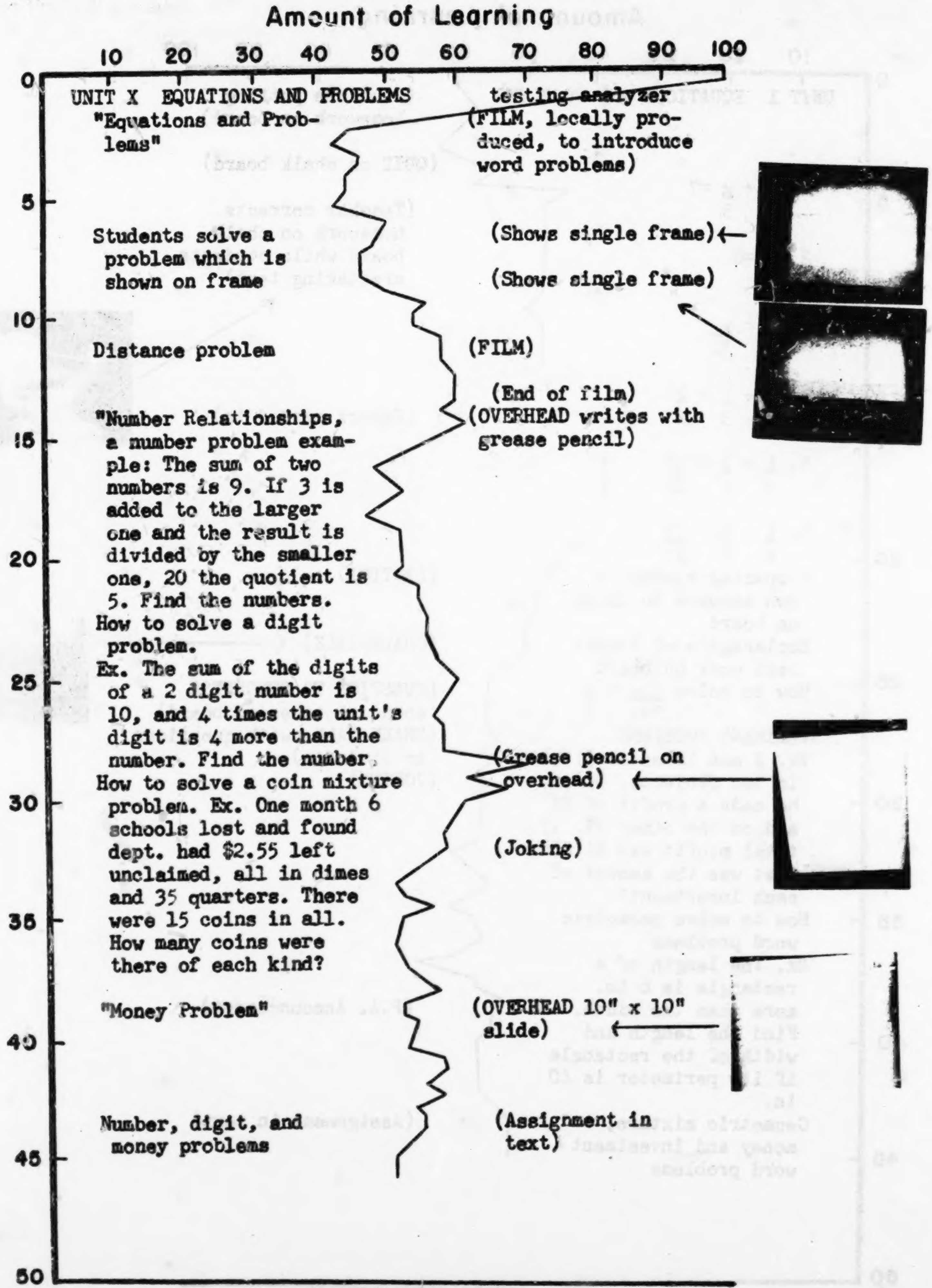
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 232



CONTROL GROUP

LEARNING PROFILE NUMBER 233



UNIT X EQUATIONS AND PROBLEMS

"Equations and Problems"

testing analyzer (FILM, locally produced, to introduce word problems)

Students solve a problem which is shown on frame

(Shows single frame)

(Shows single frame)

Distance problem

(FILM)

(End of film)

(OVERHEAD writes with grease pencil)

"Number Relationships, a number problem example: The sum of two numbers is 9. If 3 is added to the larger one and the result is divided by the smaller one, 20 the quotient is 5. Find the numbers.

How to solve a digit problem.

Ex. The sum of the digits of a 2 digit number is 10, and 4 times the unit's digit is 4 more than the number. Find the number.

(Grease pencil on overhead)

How to solve a coin mixture problem. Ex. One month 6 schools lost and found dept. had $2.55 left unclaimed, all in dimes and 35 quarters. There were 15 coins in all. How many coins were there of each kind?

(Joking)

"Money Problem"

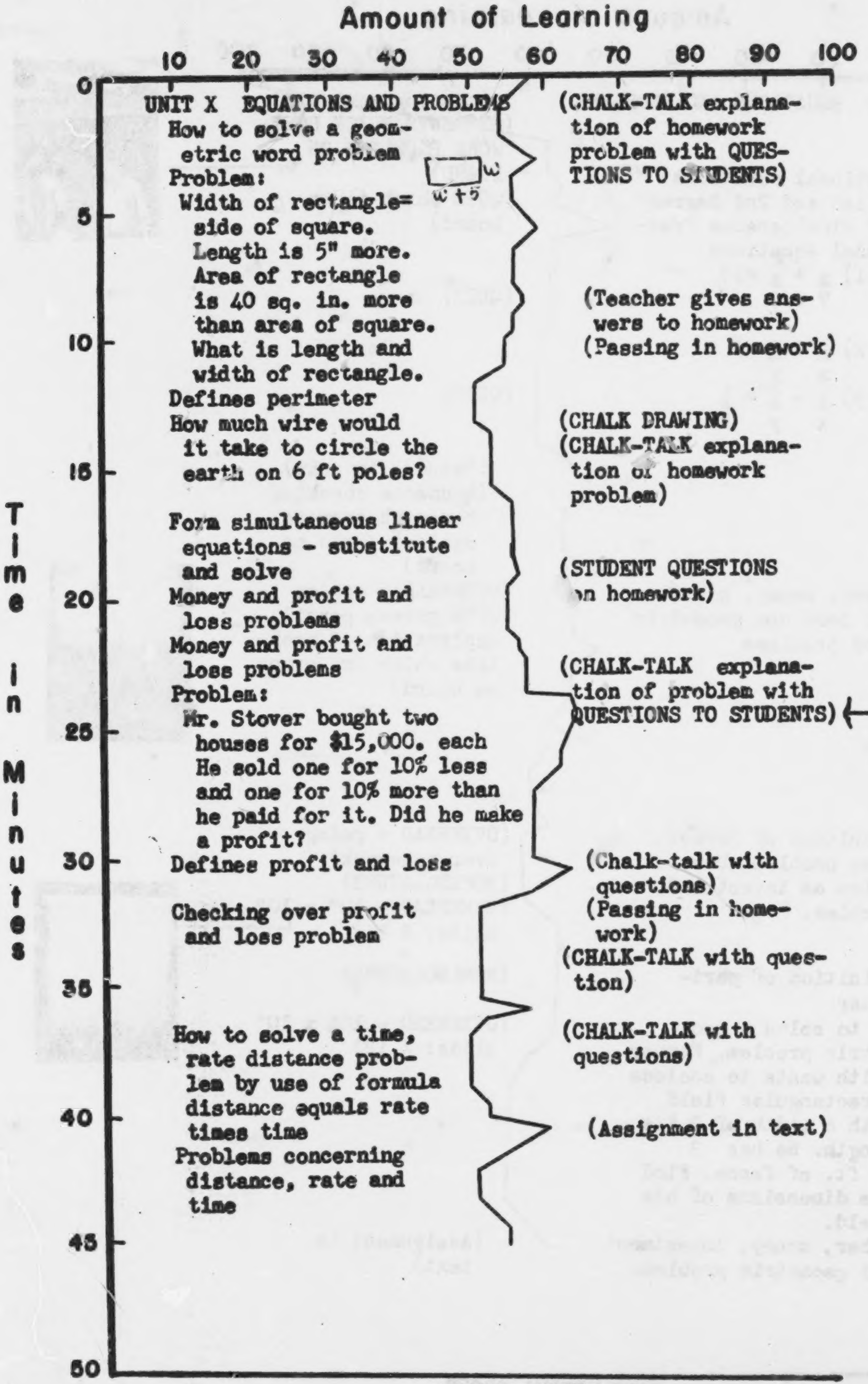
(OVERHEAD 10" x 10" slide)

Number, digit, and money problems

(Assignment in text)

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 234

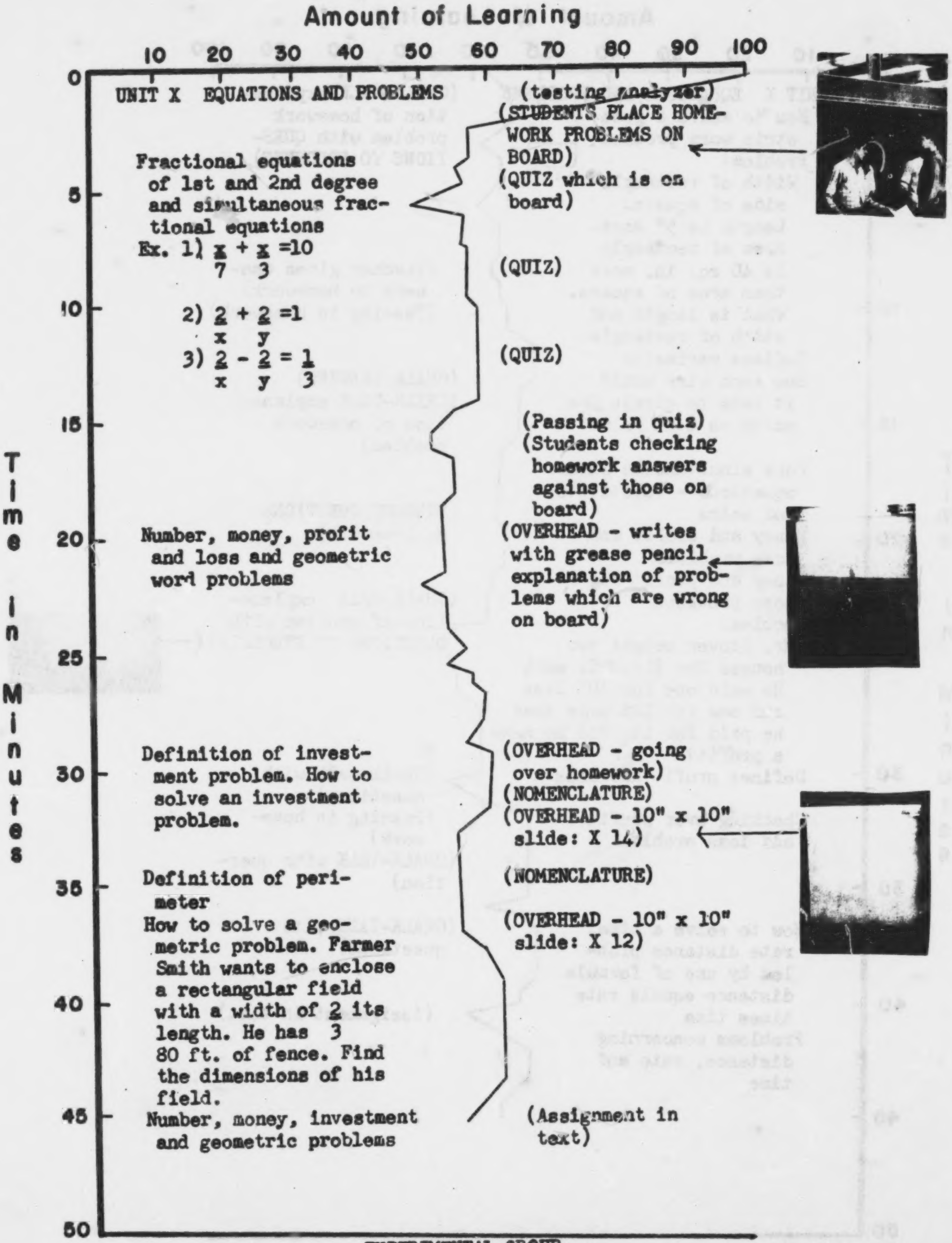


UNIT X EQUATIONS AND PROBLEMS
How to solve a geometric word problem
Problem:
Width of rectangle= side of square. Length is 5" more. Area of rectangle is 40 sq. in. more than area of square. What is length and width of rectangle.
Defines perimeter
How much wire would it take to circle the earth on 6 ft poles?
Form simultaneous linear equations - substitute and solve
Money and profit and loss problems
Money and profit and loss problems
Problem:
Mr. Stover bought two houses for $15,000. each He sold one for 10% less and one for 10% more than he paid for it. Did he make a profit?
Defines profit and loss
Checking over profit and loss problem
How to solve a time, rate distance problem by use of formula distance equals rate times time
Problems concerning distance, rate and time

(CHALK-TALK explanation of homework problem with QUESTIONS TO STUDENTS)
(Teacher gives answers to homework)
(Passing in homework)
(CHALK DRAWING)
(CHALK-TALK explanation of homework problem)
(STUDENT QUESTIONS on homework)
(CHALK-TALK explanation of problem with QUESTIONS TO STUDENTS)
(Chalk-talk with questions)
(Passing in homework)
(CHALK-TALK with question)
(CHALK-TALK with questions)
(Assignment in text)

CONTROL GROUP

LEARNING PROFILE NUMBER 235



UNIT X EQUATIONS AND PROBLEMS

Fractional equations of 1st and 2nd degree and simultaneous fractional equations

Ex. 1) $\frac{x}{7} + \frac{x}{3} = 10$

2) $\frac{2}{x} + \frac{2}{y} = 1$

3) $\frac{2}{x} - \frac{2}{y} = \frac{1}{3}$

Number, money, profit and loss and geometric word problems

Definition of investment problem. How to solve an investment problem.

Definition of perimeter

How to solve a geometric problem. Farmer Smith wants to enclose a rectangular field with a width of $\frac{2}{3}$ its length. He has 80 ft. of fence. Find the dimensions of his field.

Number, money, investment and geometric problems

(testing analyzer)

(STUDENTS PLACE HOMEWORK PROBLEMS ON BOARD)

(QUIZ which is on board)

(QUIZ)

(QUIZ)

(Passing in quiz)

(Students checking homework answers against those on board)

(OVERHEAD - writes with grease pencil explanation of problems which are wrong on board)

(OVERHEAD - going over homework)

(NOMENCLATURE)

(OVERHEAD - 10" x 10" slide: X 14)

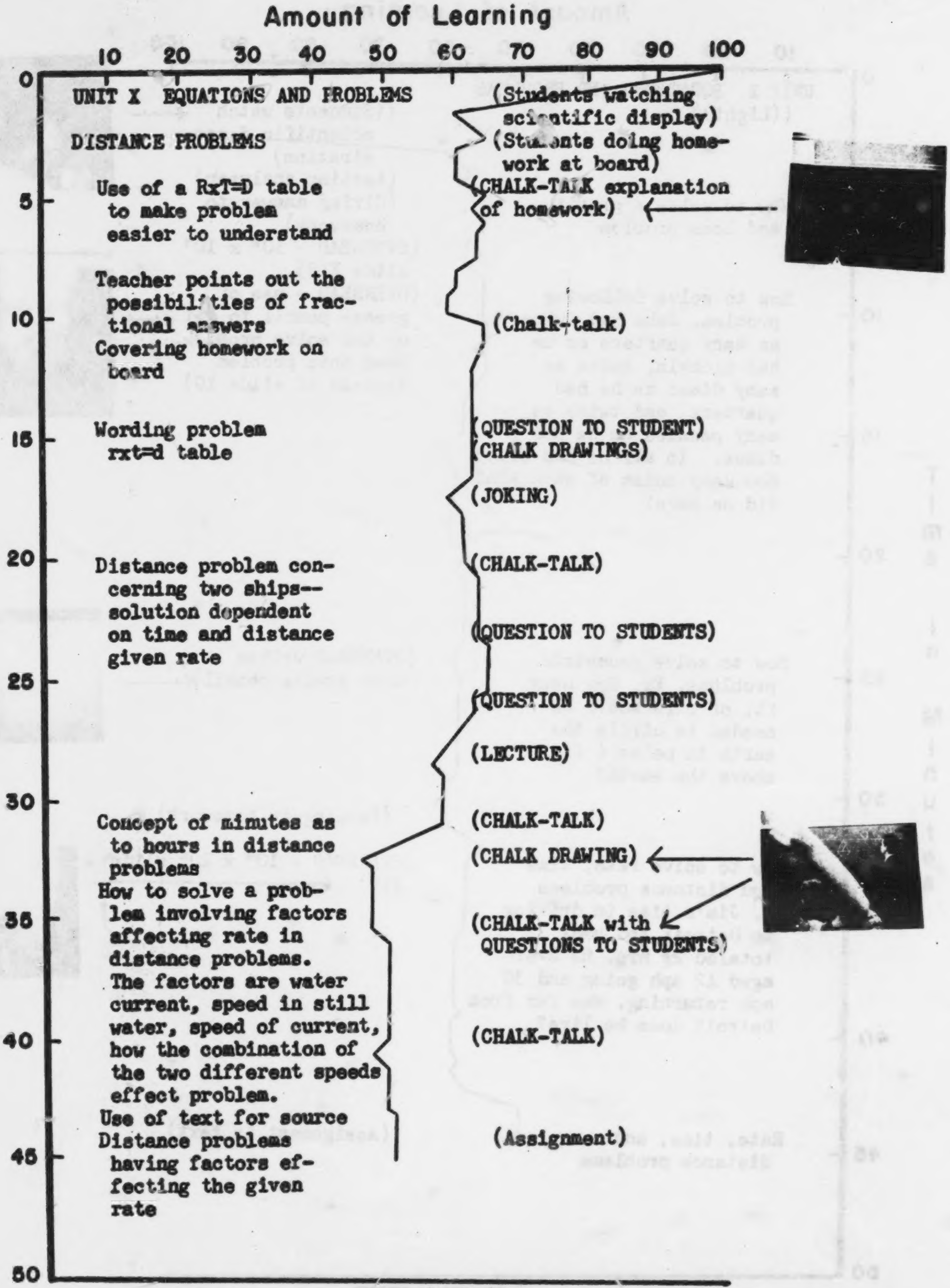
(NOMENCLATURE)

(OVERHEAD - 10" x 10" slide: X 12)

(Assignment in text)

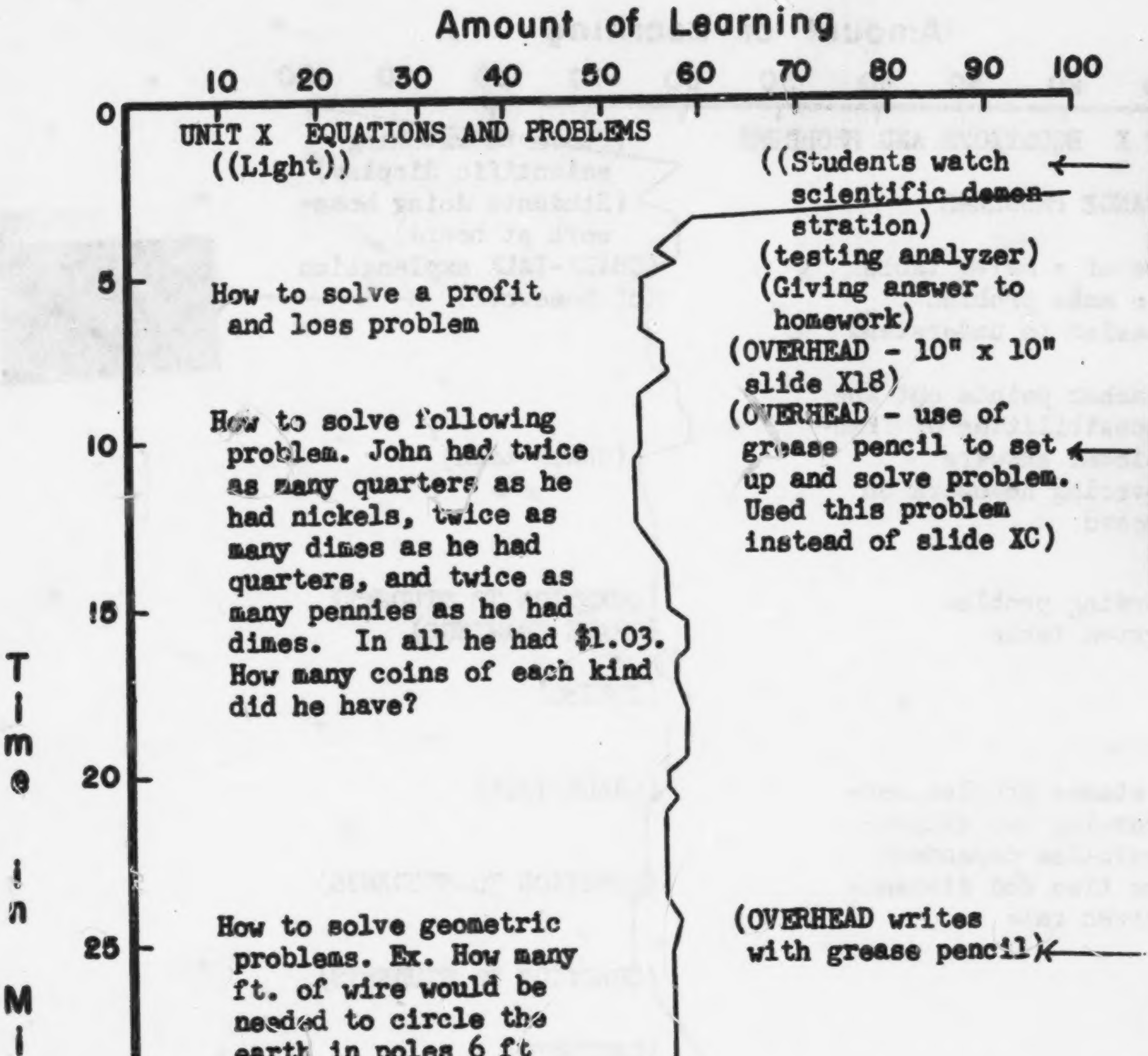
EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 236



CONTROL GROUP

LEARNING PROFILE NUMBER 237



UNIT X EQUATIONS AND PROBLEMS
((Light))

How to solve a profit and loss problem

How to solve following problem. John had twice as many quarters as he had nickels, twice as many dimes as he had quarters, and twice as many pennies as he had dimes. In all he had $1.03. How many coins of each kind did he have?

How to solve geometric problems. Ex. How many ft. of wire would be needed to circle the earth in poles 6 ft above the earth?

How to solve rate, time and distance problems Ex. Jim's time in driving to Detroit and back totaled 2½ hrs. He averaged 42 mph going and 30 mph returning. How far from Detroit does he live?

Rate, time, and distance problems

((Students watch scientific demonstration)

(testing analyzer)

(Giving answer to homework)

(OVERHEAD - 10" x 10" slide X18)

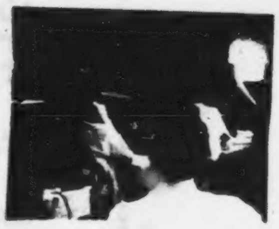
(OVERHEAD - use of grease pencil to set up and solve problem. Used this problem instead of slide XC)

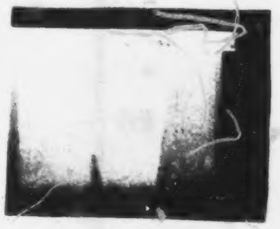
(OVERHEAD writes with grease pencil)

(Passing in homework)

(OVERHEAD - 10" x 10" slide; X19)

(Assignment in text)





EXPERIMENTAL GROUP

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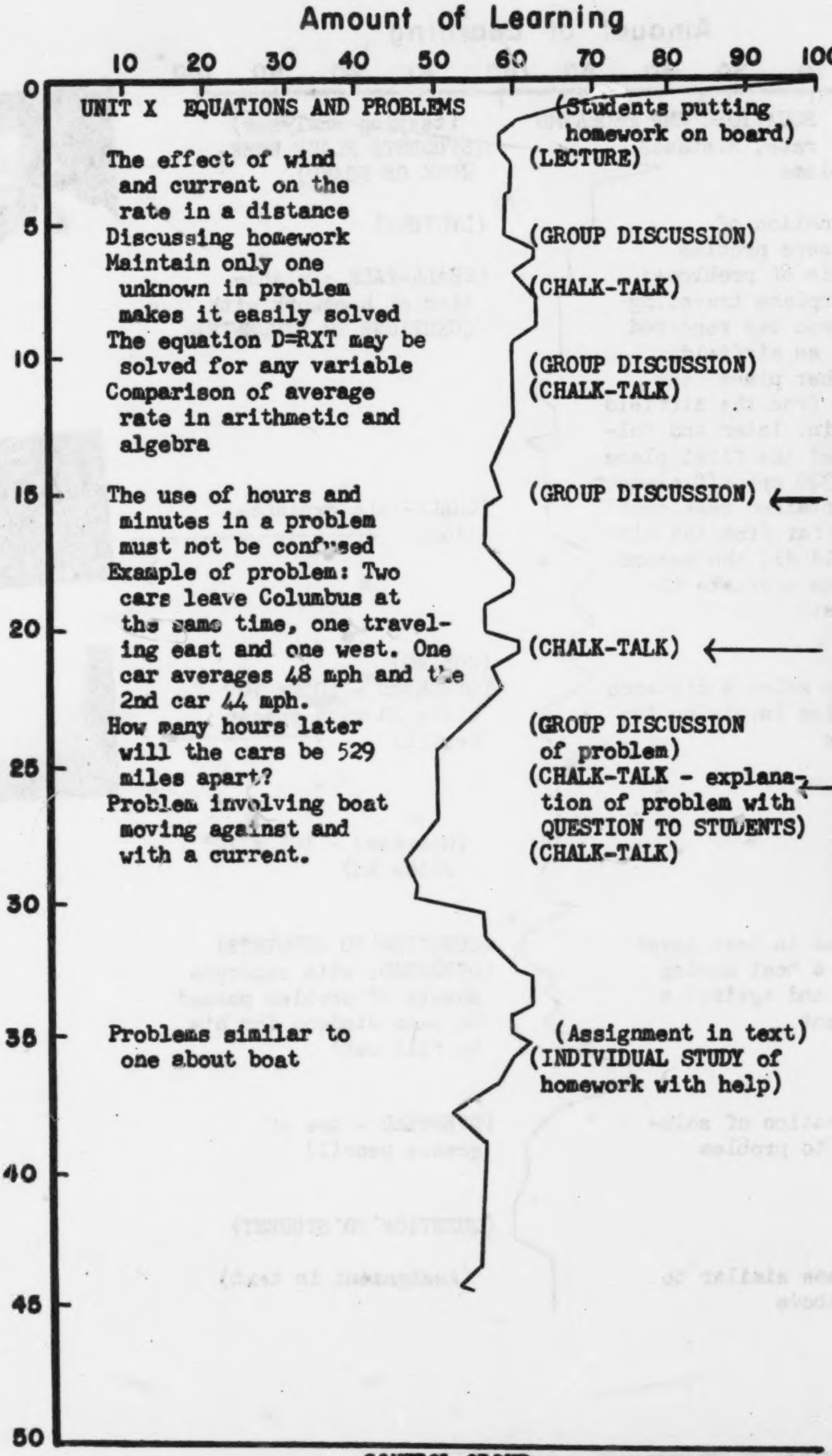
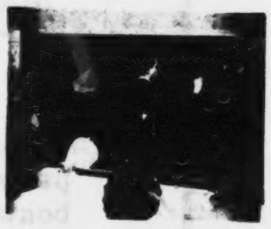
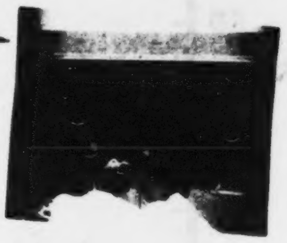
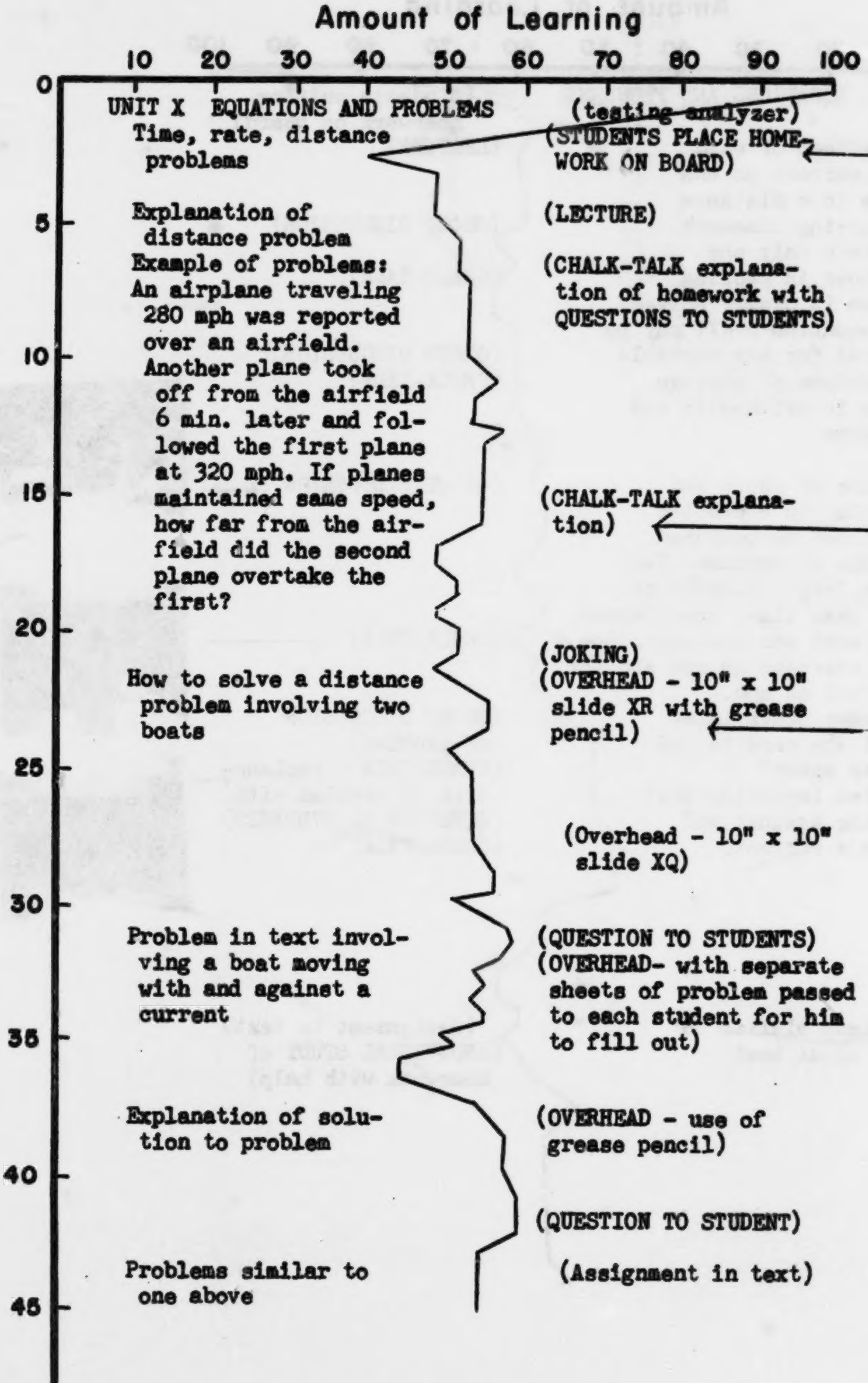






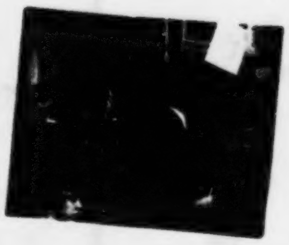
CONTROL GROUP

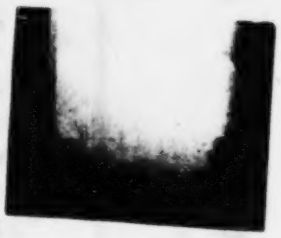
LEARNING PROFILE NUMBER 239



UNIT X EQUATIONS AND PROBLEMS
Time, rate, distance problems
Explanation of distance problem
Example of problems: An airplane traveling 280 mph was reported over an airfield. Another plane took off from the airfield 6 min. later and followed the first plane at 320 mph. If planes maintained same speed, how far from the airfield did the second plane overtake the first?
How to solve a distance problem involving two boats
Problem in text involving a boat moving with and against a current
Explanation of solution to problem
Problems similar to one above

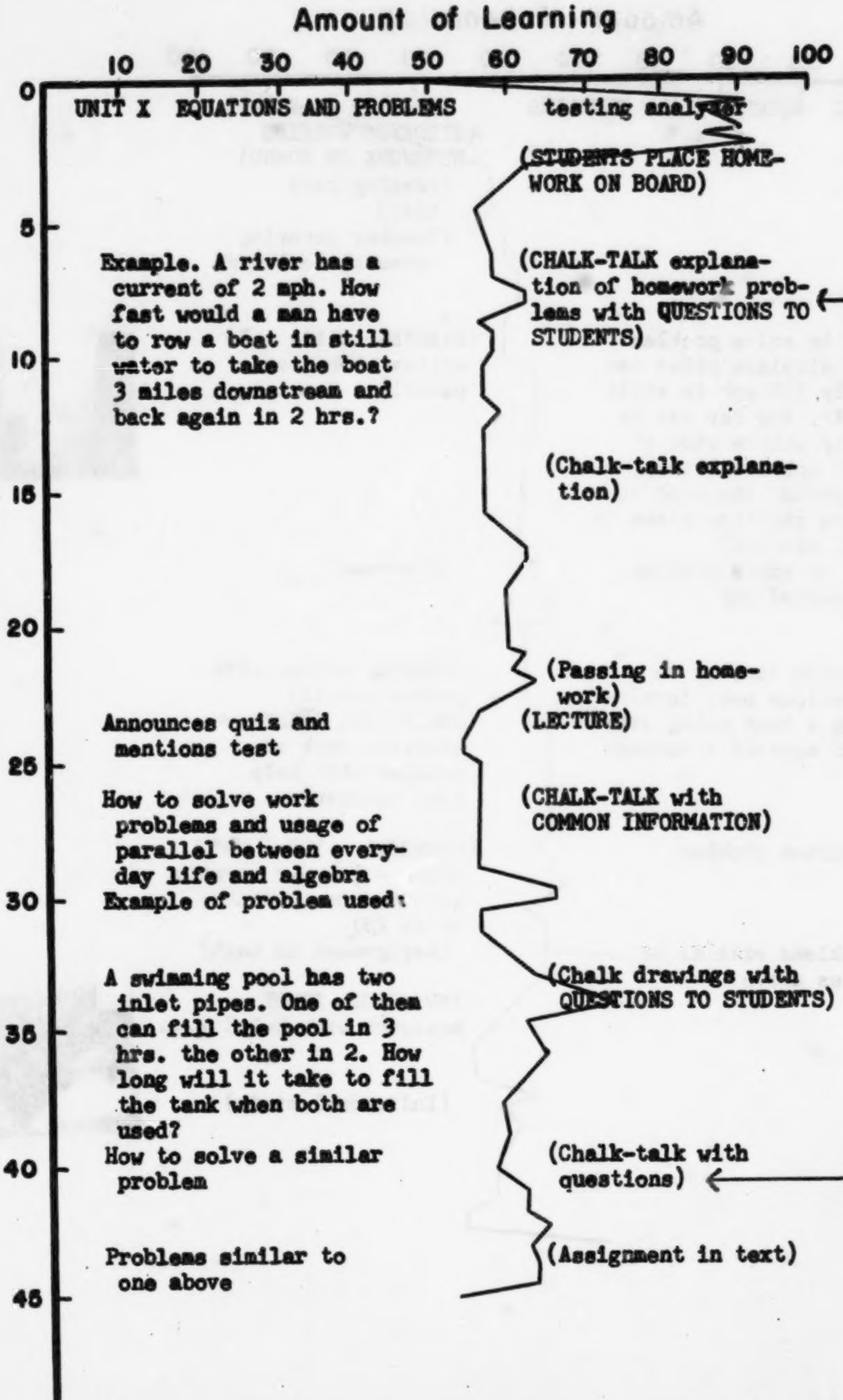
(testing analyzer)
(STUDENTS PLACE HOMEWORK ON BOARD)
(LECTURE)
(CHALK-TALK explanation of homework with QUESTIONS TO STUDENTS)
(CHALK-TALK explanation)
(JOKING)
(OVERHEAD - 10" x 10" slide XR with grease pencil)
(Overhead - 10" x 10" slide XQ)
(QUESTION TO STUDENTS)
(OVERHEAD- with separate sheets of problem passed to each student for him to fill out)
(OVERHEAD - use of grease pencil)
(QUESTION TO STUDENT)
(Assignment in text)

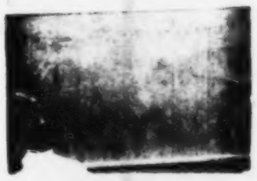




EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 240





CONTROL GROUP

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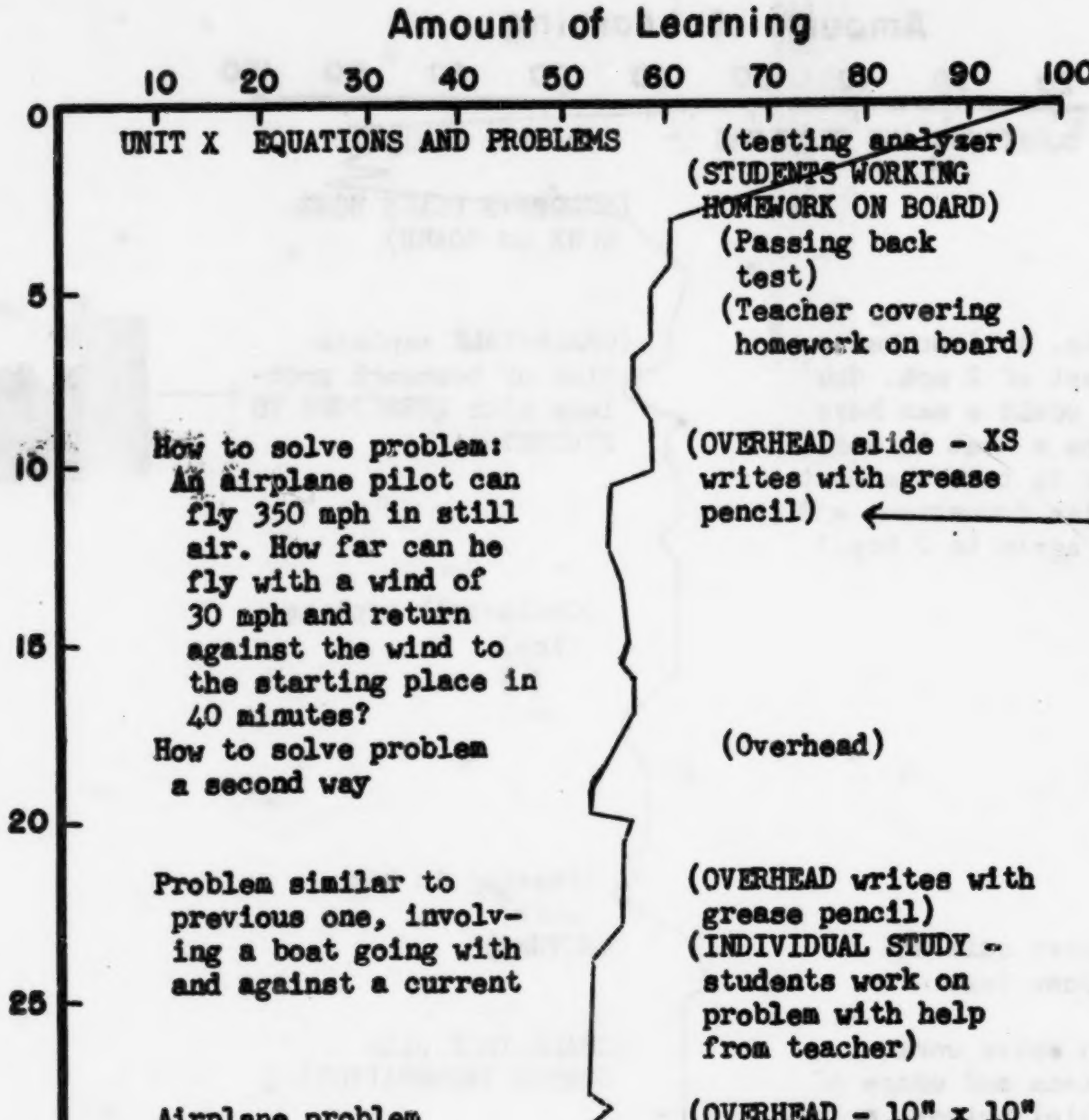


UNIT X EQUATIONS AND PROBLEMS

(testing analyzer)

(STUDENTS WORKING HOMEWORK ON BOARD)

(Passing back test)

(Teacher covering homework on board)

How to solve problem: An airplane pilot can fly 350 mph in still air. How far can he fly with a wind of 30 mph and return against the wind to the starting place in 40 minutes?

(OVERHEAD slide - XS writes with grease pencil)

How to solve problem a second way

(Overhead)

Problem similar to previous one, involving a boat going with and against a current

(OVERHEAD writes with grease pencil)

(INDIVIDUAL STUDY - students work on problem with help from teacher)

Airplane problem

(OVERHEAD - 10" x 10" slide - teacher reveals solution to students; Slide XS)

Problems similar to ones above

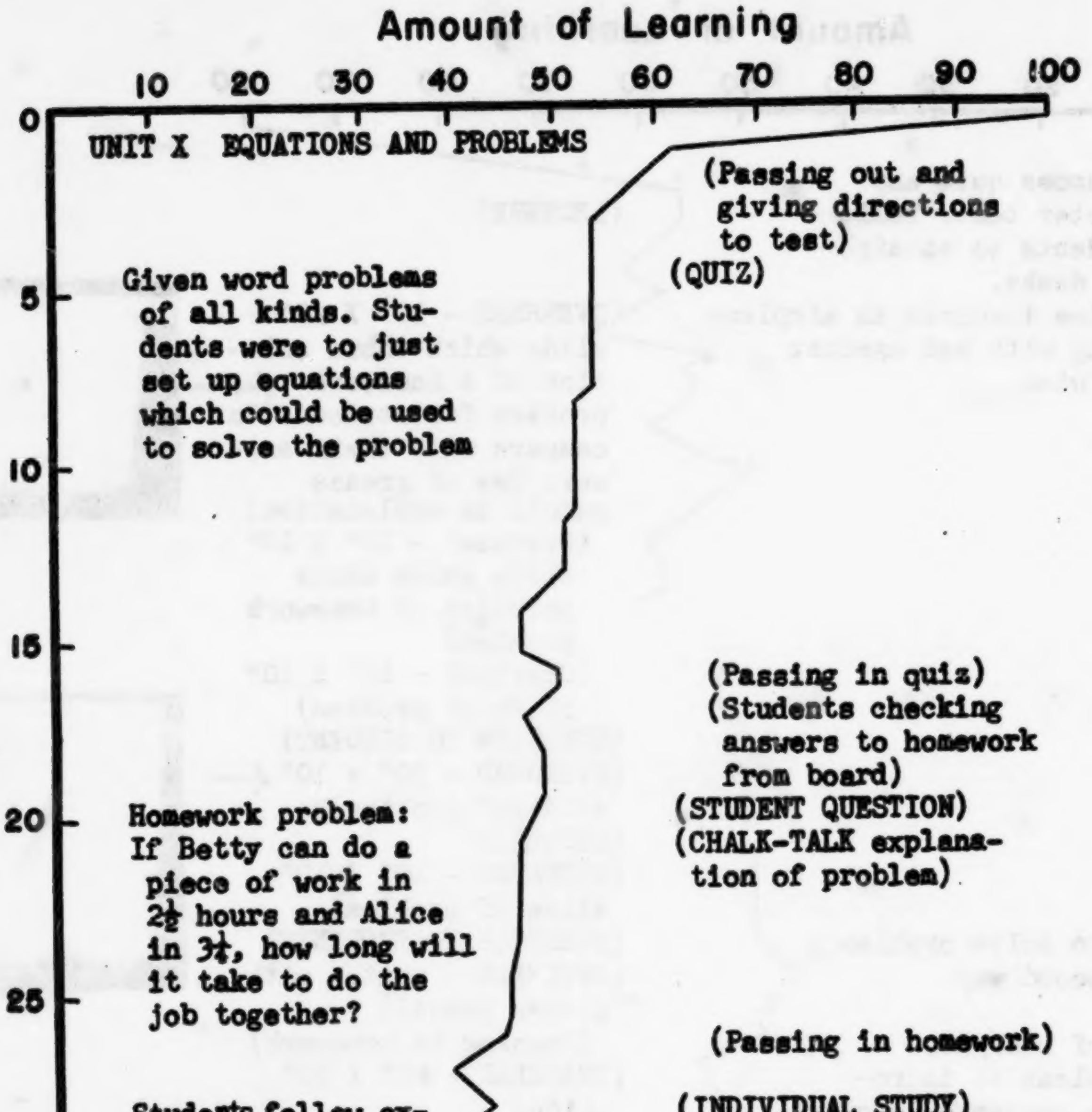
(Assignment in text)

(INDIVIDUAL STUDY on homework with help)

(Individual study)

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 242



UNIT X EQUATIONS AND PROBLEMS

(Passing out and giving directions to test)

(QUIZ)

Given word problems of all kinds. Students were to just set up equations which could be used to solve the problem

(Passing in quiz)
(Students checking answers to homework from board)
(STUDENT QUESTION)
(CHALK-TALK explanation of problem)

Homework problem: If Betty can do a piece of work in 2½ hours and Alice in 3¼, how long will it take to do the job together?

(Passing in homework)

(INDIVIDUAL STUDY)

Students follow example of mixture problem in text. How to set up and solve a mixture problem.

Ex. How much alcohol must be added to 20 gallons of a 10% solution to get a 12% solution?

(CHALK TALK with QUESTIONS TO STUDENTS)

Summarization of method of approach

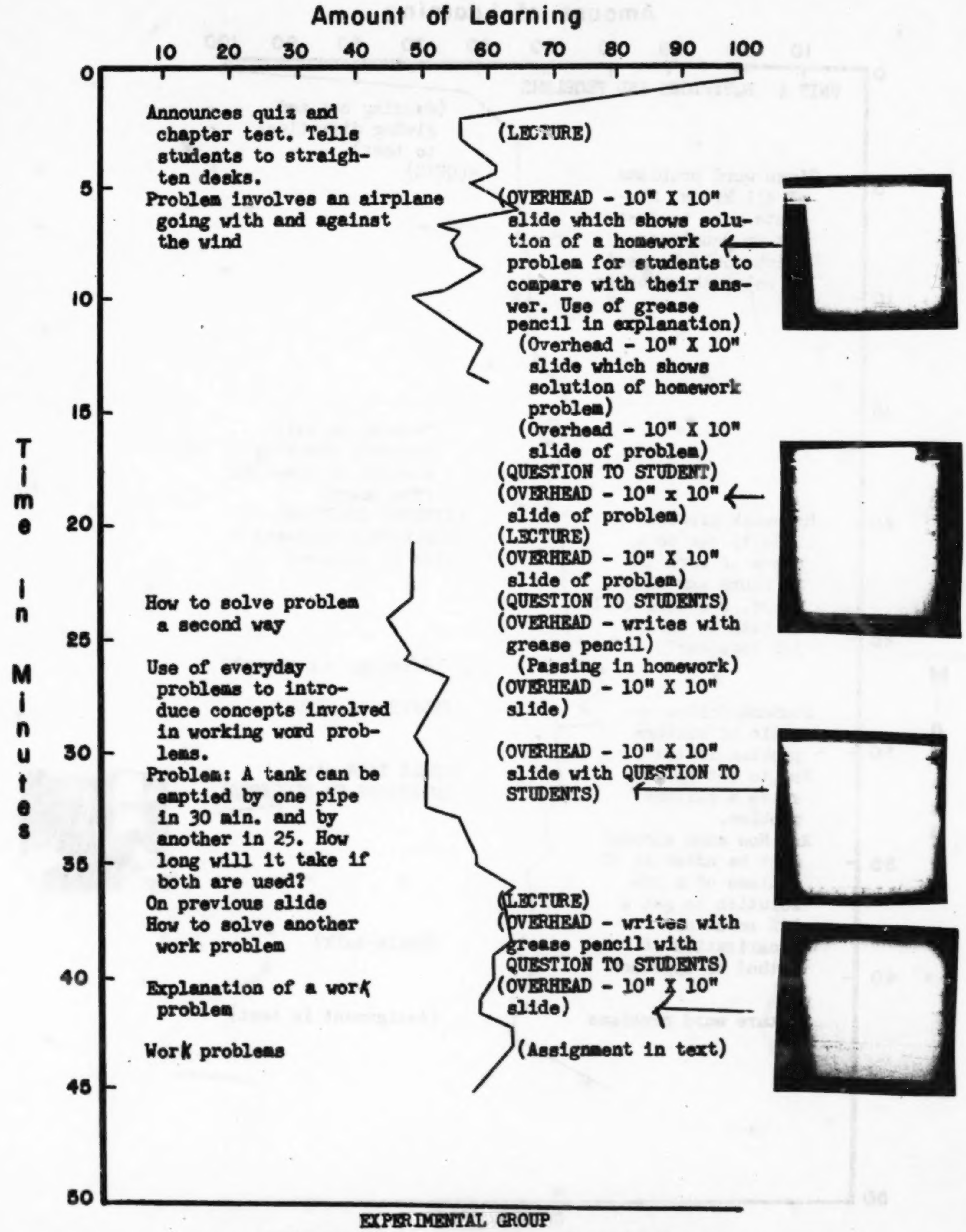
(Chalk-talk)

Mixture word problems

(Assignment in text)

CONTROL GROUP

LEARNING PROFILE NUMBER 243



Announces quiz and chapter test. Tells students to straighten desks.

Problem involves an airplane going with and against the wind

How to solve problem a second way

Use of everyday problems to introduce concepts involved in working word problems.

Problem: A tank can be emptied by one pipe in 30 min. and by another in 25. How long will it take if both are used?

On previous slide

How to solve another work problem

Explanation of a work problem

Work problems

(LECTURE)

(OVERHEAD - 10" X 10" slide which shows solution of a homework problem for students to compare with their answer. Use of grease pencil in explanation)

(Overhead - 10" X 10" slide which shows solution of homework problem)

(Overhead - 10" X 10" slide of problem)

(QUESTION TO STUDENT)

(OVERHEAD - 10" x 10" slide of problem)

(LECTURE)

(OVERHEAD - 10" X 10" slide of problem)

(QUESTION TO STUDENTS)

(OVERHEAD - writes with grease pencil)

(Passing in homework)

(OVERHEAD - 10" X 10" slide)

(OVERHEAD - 10" X 10" slide with QUESTION TO STUDENTS)

(LECTURE)

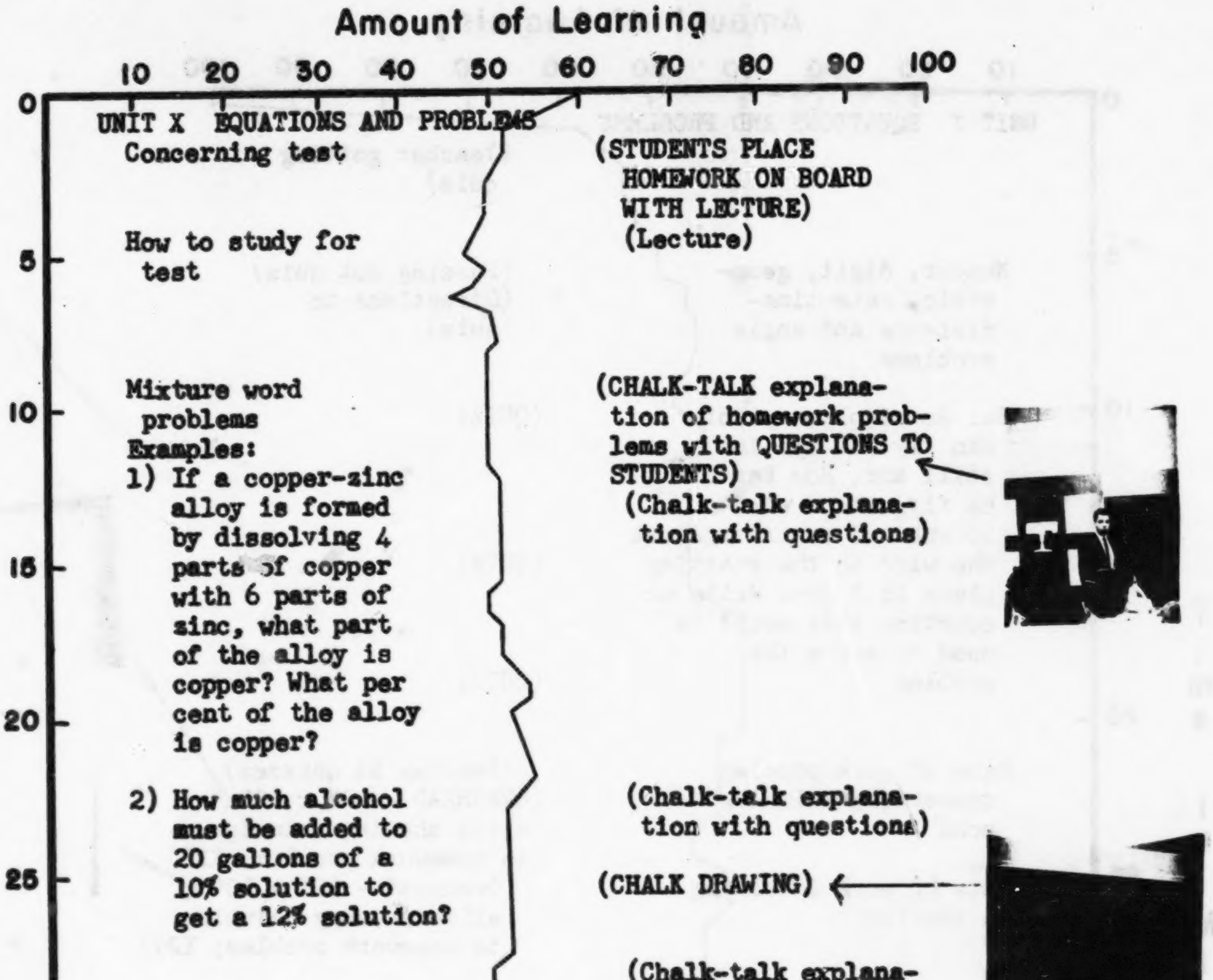
(OVERHEAD - writes with grease pencil with QUESTION TO STUDENTS)

(OVERHEAD - 10" X 10" slide)

(Assignment in text)

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 244



UNIT X EQUATIONS AND PROBLEMS

Concerning test

How to study for test

Mixture word problems

Examples:

1) If a copper-zinc alloy is formed by dissolving 4 parts of copper with 6 parts of zinc, what part of the alloy is copper? What per cent of the alloy is copper?

2) How much alcohol must be added to 20 gallons of a 10% solution to get a 12% solution?

Chapter Test on Equations and Problems

(STUDENTS PLACE HOMEWORK ON BOARD WITH LECTURE)

(Lecture)

(CHALK-TALK explanation of homework problems with QUESTIONS TO STUDENTS)

(Chalk-talk explanation with questions)

(Chalk-talk explanation with questions)

(CHALK DRAWING)

(Chalk-talk explanation with questions)

(Assignment in text)

(Teacher gives answers to homework)

(Passing in homework)

CONTROL GROUP

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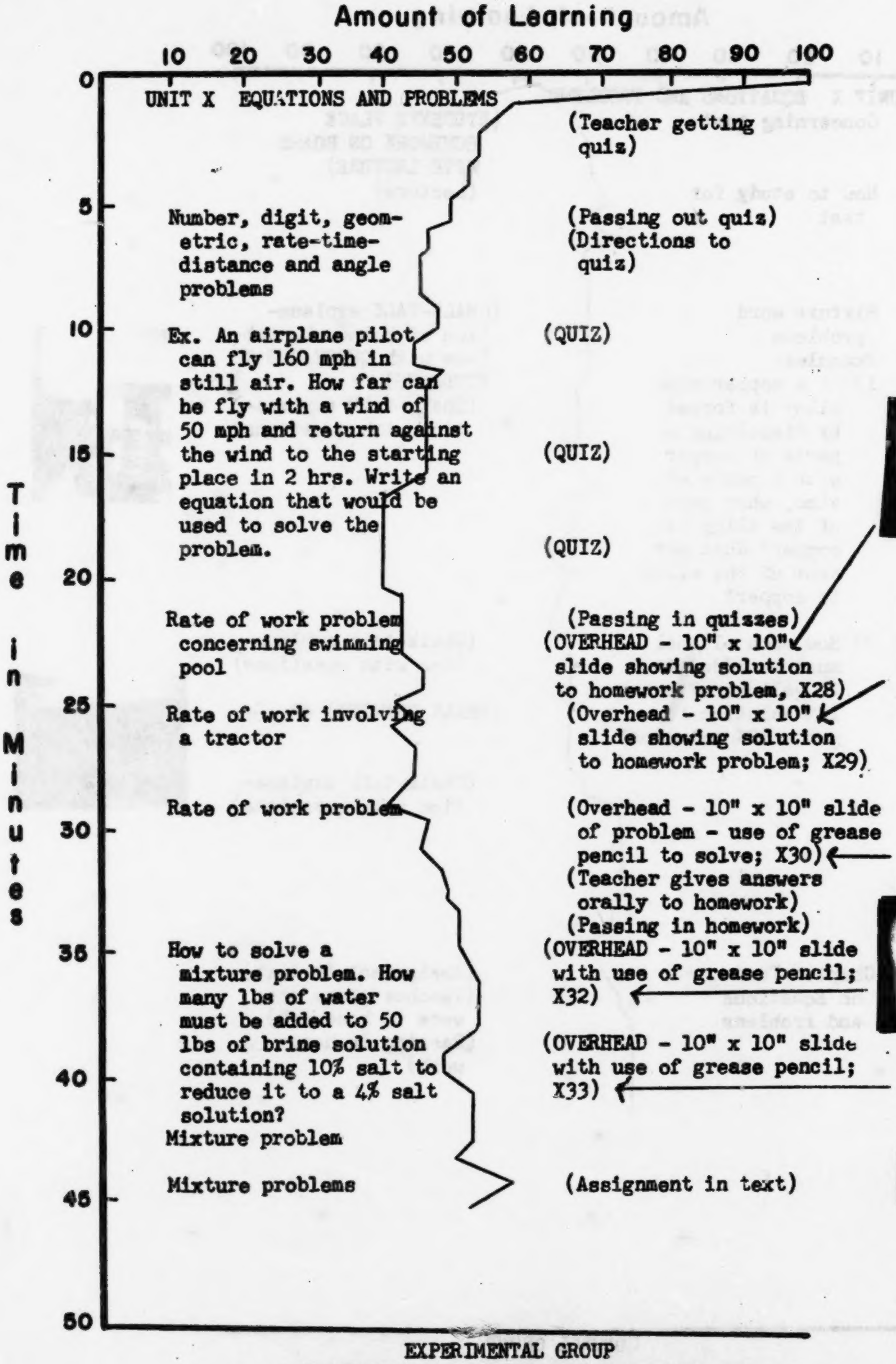


UNIT X EQUATIONS AND PROBLEMS

(Teacher getting quiz)

Number, digit, geometric, rate-time-distance and angle problems

(Passing out quiz)
(Directions to quiz)

Ex. An airplane pilot can fly 160 mph in still air. How far can he fly with a wind of 50 mph and return against the wind to the starting place in 2 hrs. Write an equation that would be used to solve the problem.

(QUIZ)

(QUIZ)

(QUIZ)

Rate of work problem concerning swimming pool

(Passing in quizzes)
(OVERHEAD - 10" x 10" slide showing solution to homework problem, X28)

Rate of work involving a tractor

(Overhead - 10" x 10" slide showing solution to homework problem; X29)

Rate of work problem

(Overhead - 10" x 10" slide of problem - use of grease pencil to solve; X30)
(Teacher gives answers orally to homework)
(Passing in homework)

How to solve a mixture problem. How many lbs of water must be added to 50 lbs of brine solution containing 10% salt to reduce it to a 4% salt solution?

(OVERHEAD - 10" x 10" slide with use of grease pencil; X32)

(OVERHEAD - 10" x 10" slide with use of grease pencil; X33)

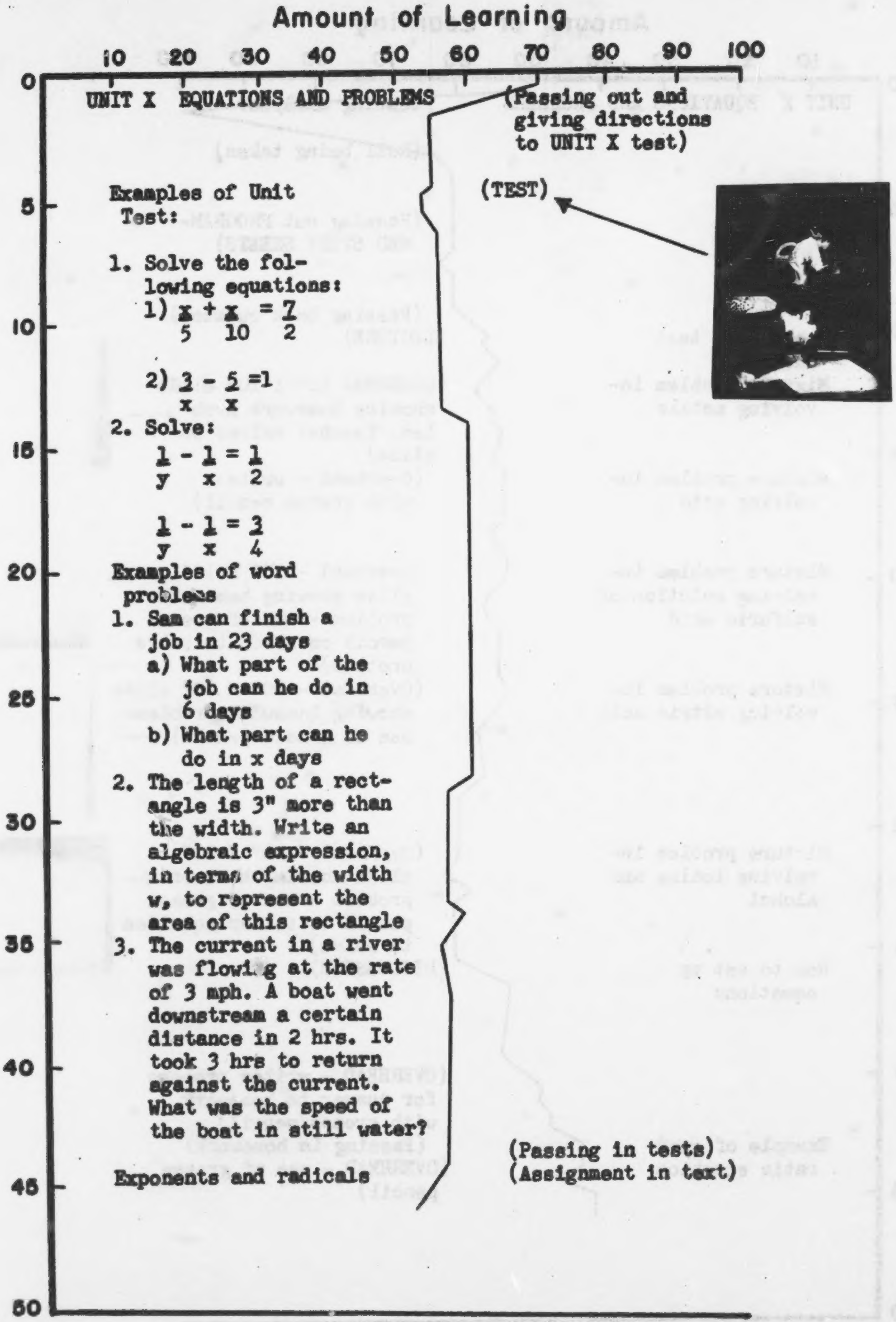
Mixture problem

Mixture problems

(Assignment in text)

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 246



UNIT X EQUATIONS AND PROBLEMS

(Passing out and
giving directions
to UNIT X test)

Examples of Unit Test:

1. Solve the following equations:
   1) $\frac{x}{5} + \frac{x}{10} = \frac{7}{2}$
   2) $\frac{3}{x} - \frac{5}{x} = 1$
2. Solve:
   $\frac{1}{y} - \frac{1}{x} = \frac{1}{2}$
   $\frac{1}{y} - \frac{1}{x} = \frac{3}{4}$

Examples of word problems

1. Sam can finish a job in 23 days
   a) What part of the job can he do in 6 days
   b) What part can he do in x days
2. The length of a rectangle is 3" more than the width. Write an algebraic expression, in terms of the width w, to represent the area of this rectangle
3. The current in a river was flowing at the rate of 3 mph. A boat went downstream a certain distance in 2 hrs. It took 3 hrs to return against the current. What was the speed of the boat in still water?

Exponents and radicals

(Passing in tests)
(Assignment in text)

CONTROL GROUP

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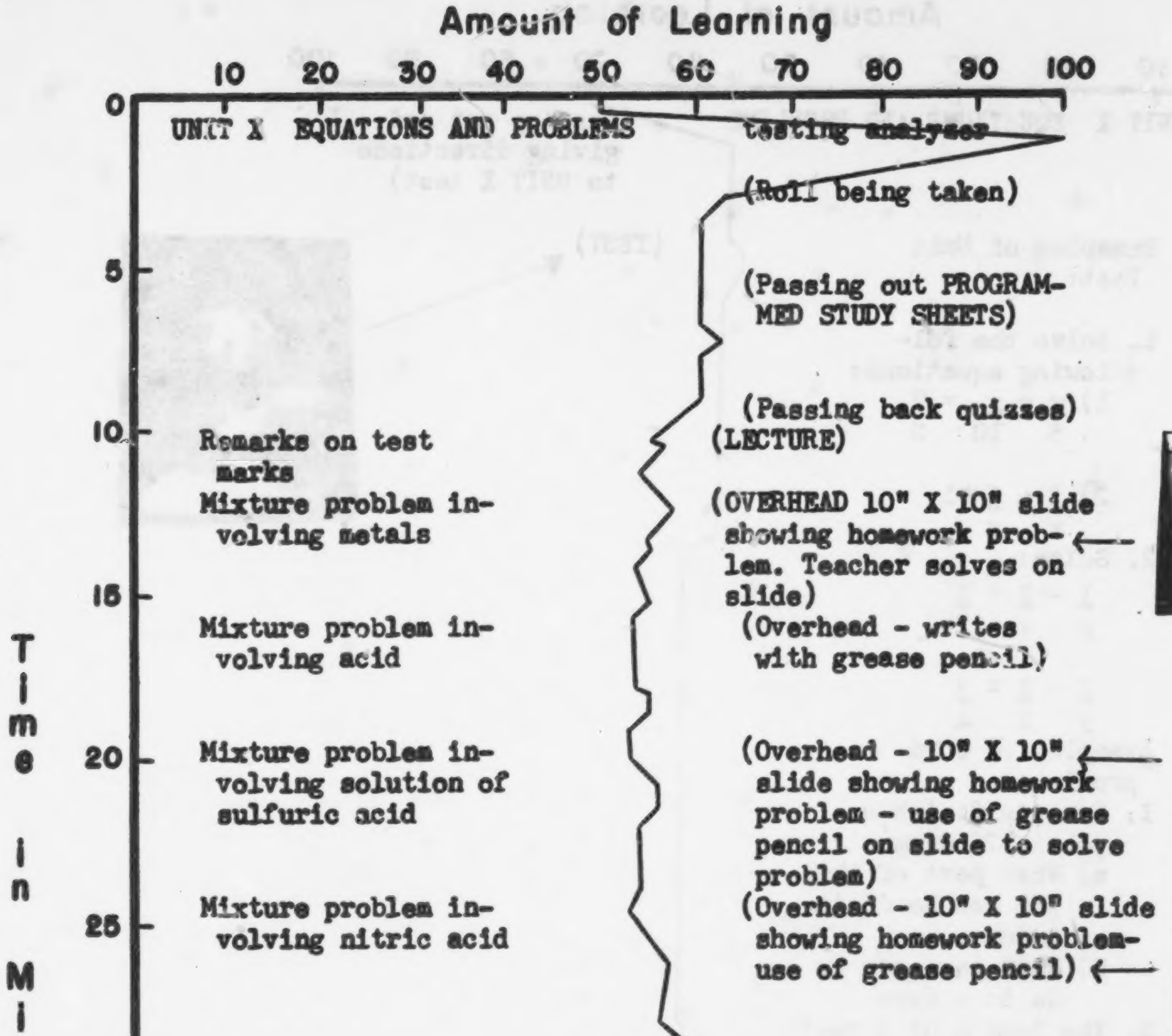

EXPERIMENTAL GROUP

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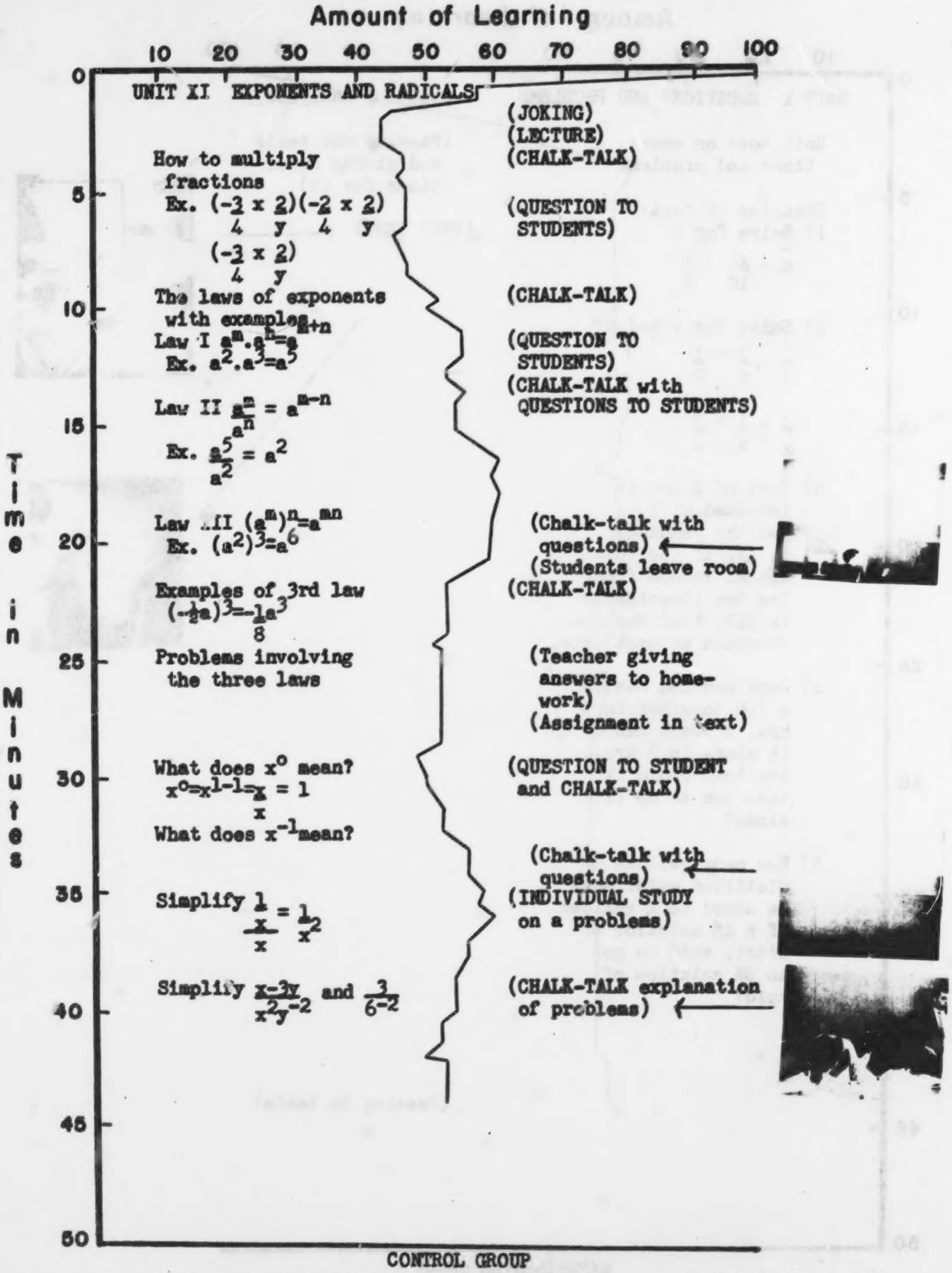

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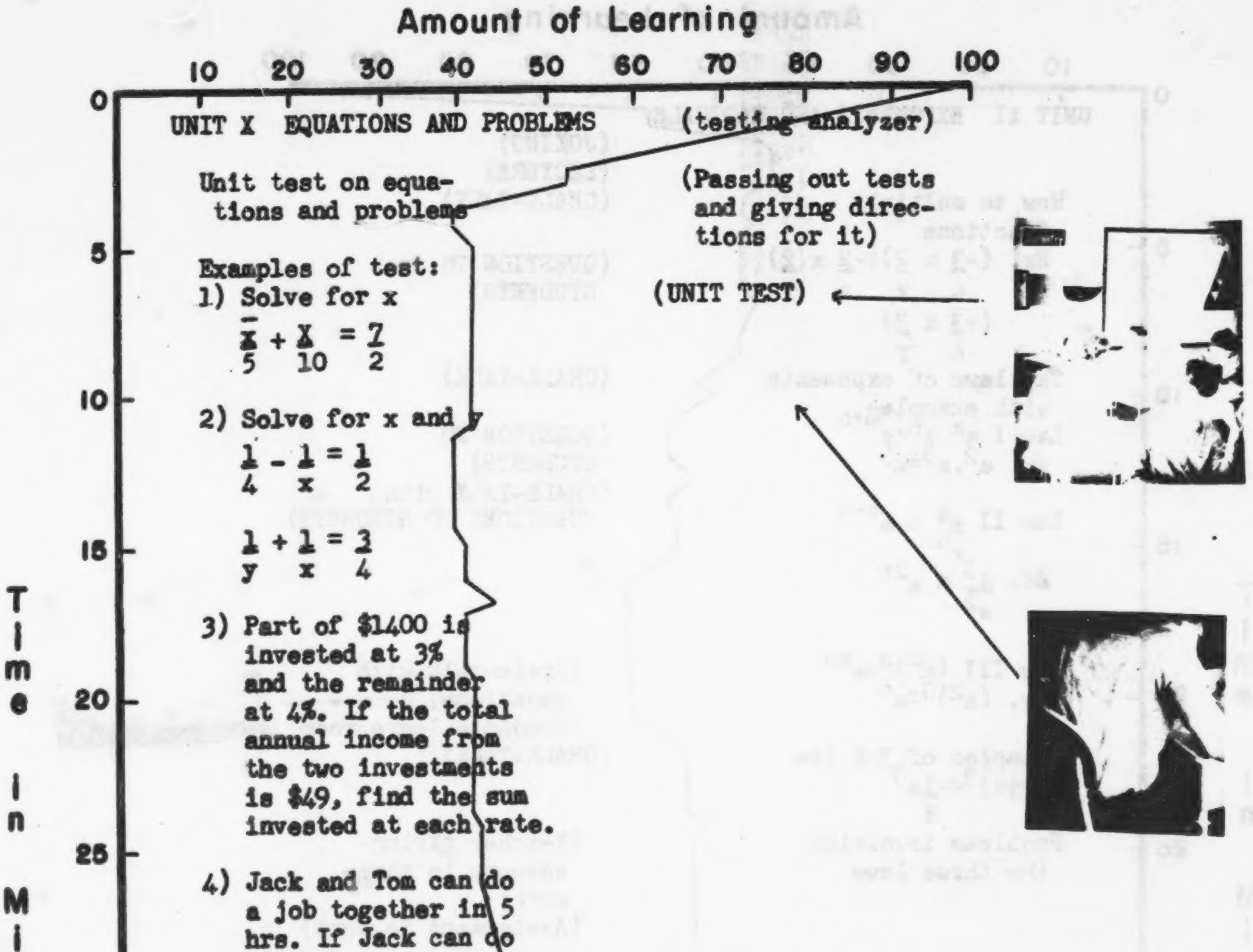

UNIT X EQUATIONS AND PROBLEMS

(testing analyzer)

Unit test on equations and problems

(Passing out tests and giving directions for it)

Examples of test:

1) Solve for x

$$\frac{x}{5} + \frac{x}{10} = \frac{7}{2}$$

(UNIT TEST)

2) Solve for x and y

$$\frac{1}{4} - \frac{1}{x} = \frac{1}{2}$$

$$\frac{1}{y} + \frac{1}{x} = \frac{3}{4}$$

3) Part of $1400 is invested at 3% and the remainder at 4%. If the total annual income from the two investments is $49, find the sum invested at each rate.

4) Jack and Tom can do a job together in 5 hrs. If Jack can do it alone in 7 hrs., how long would it take Tom to do it alone?

5) How many gallons of distilled water must be added to 4 gallons of a 4% solution of nitric acid to get an 8% solution of acid?

(Passing in tests)

EXPERIMENTAL GROUP

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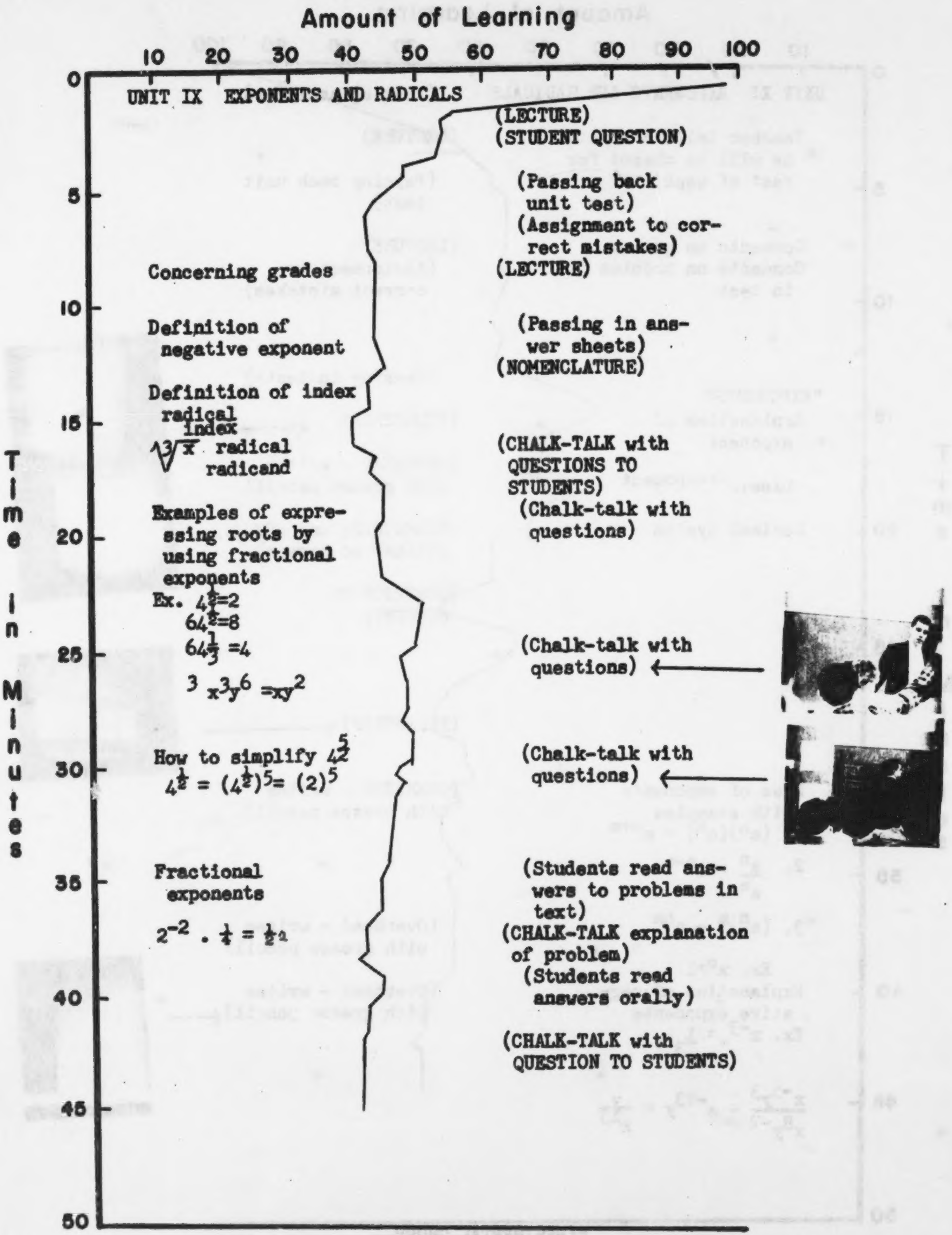

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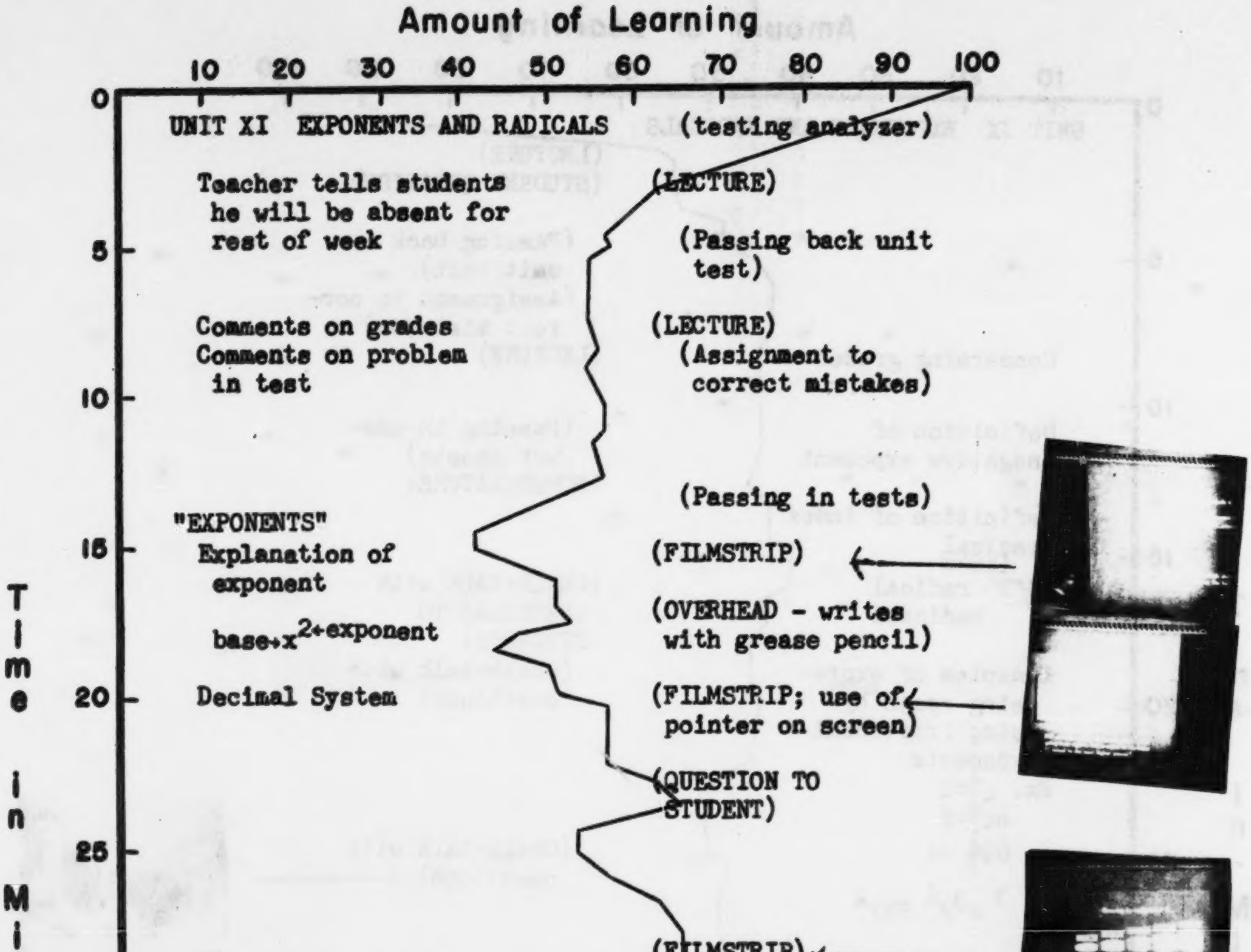

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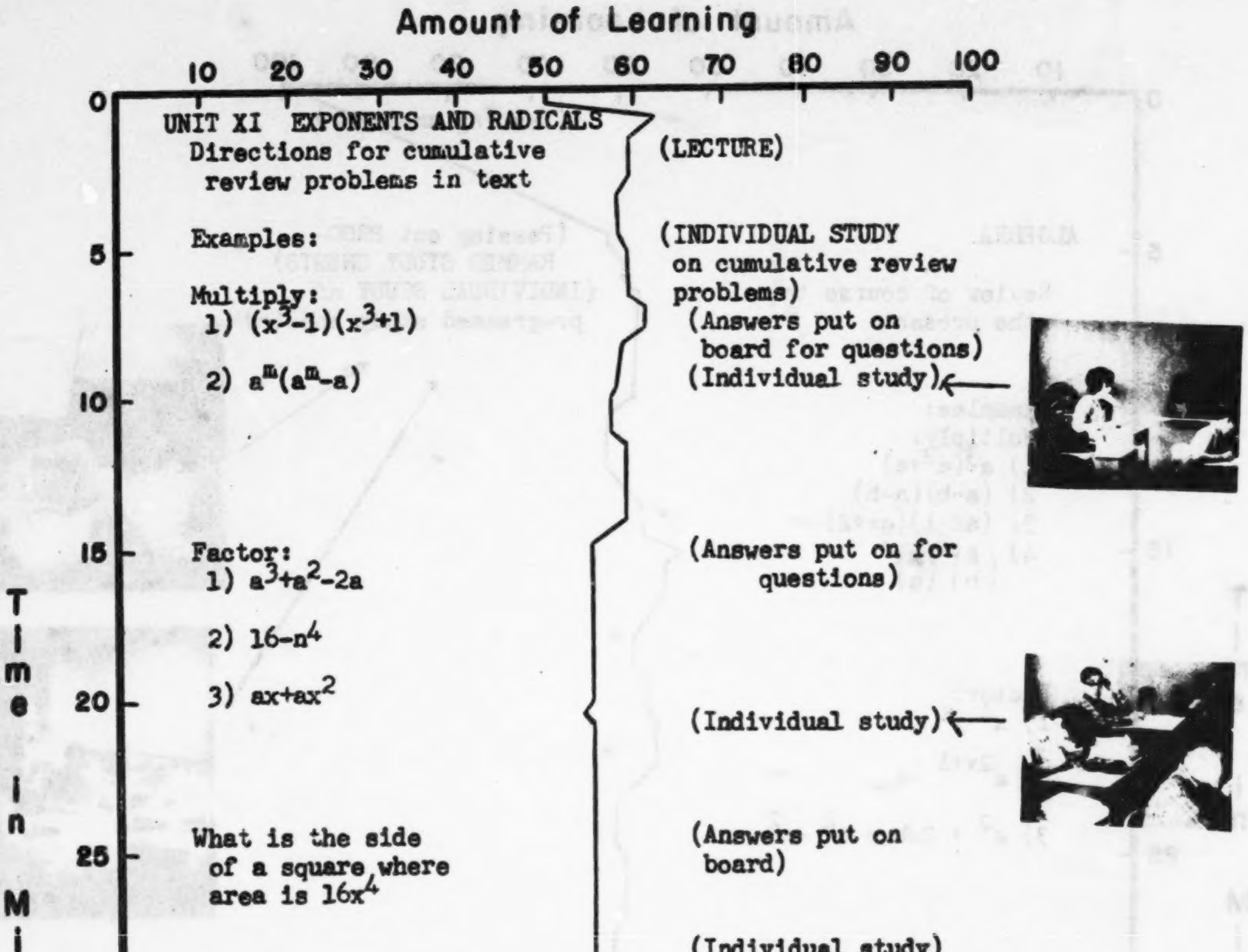

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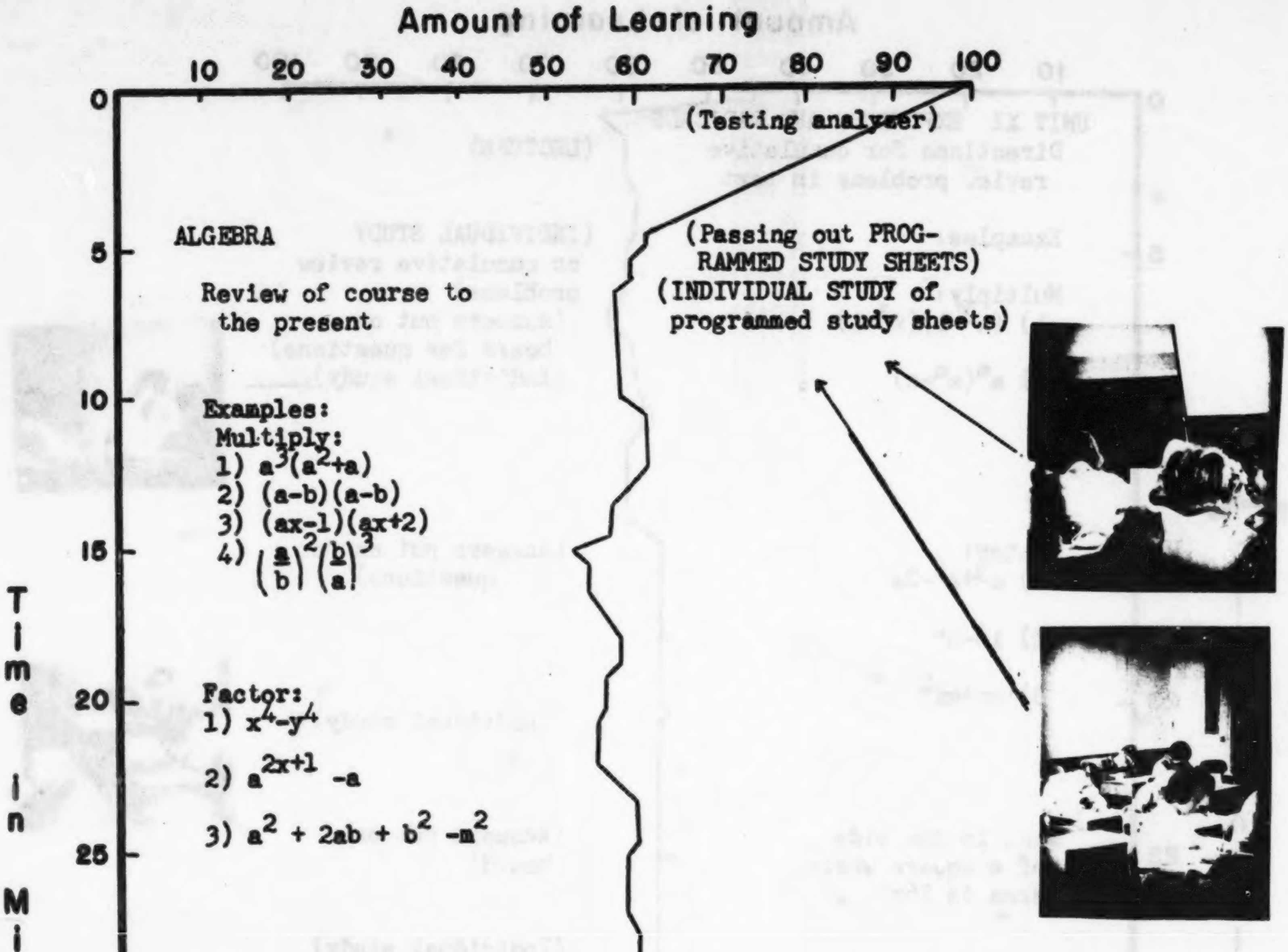

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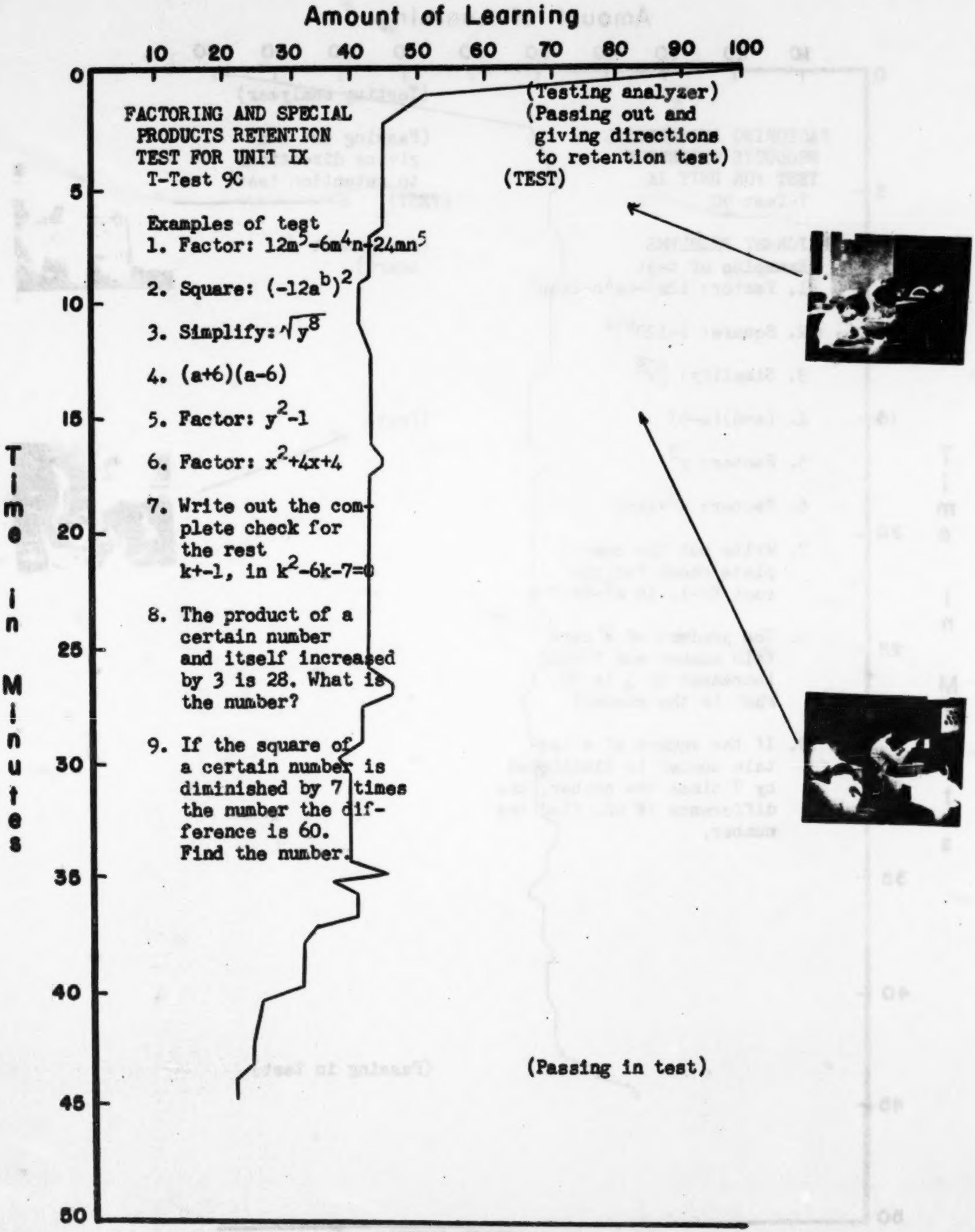

FACTORING AND SPECIAL PRODUCTS RETENTION TEST FOR UNIT IX
T-Test 9C

Examples of test
1. Factor: $12m^5-6m^4n+24mn^5$
2. Square: $(-12a^b)^2$
3. Simplify: $\sqrt{y^8}$
4. $(a+6)(a-6)$
5. Factor: y^2-1
6. Factor: x^2+4x+4
7. Write out the complete check for the rest $k+-1$, in $k^2-6k-7=0$
8. The product of a certain number and itself increased by 3 is 28. What is the number?
9. If the square of a certain number is diminished by 7 times the number the difference is 60. Find the number.

CONTROL GROUP

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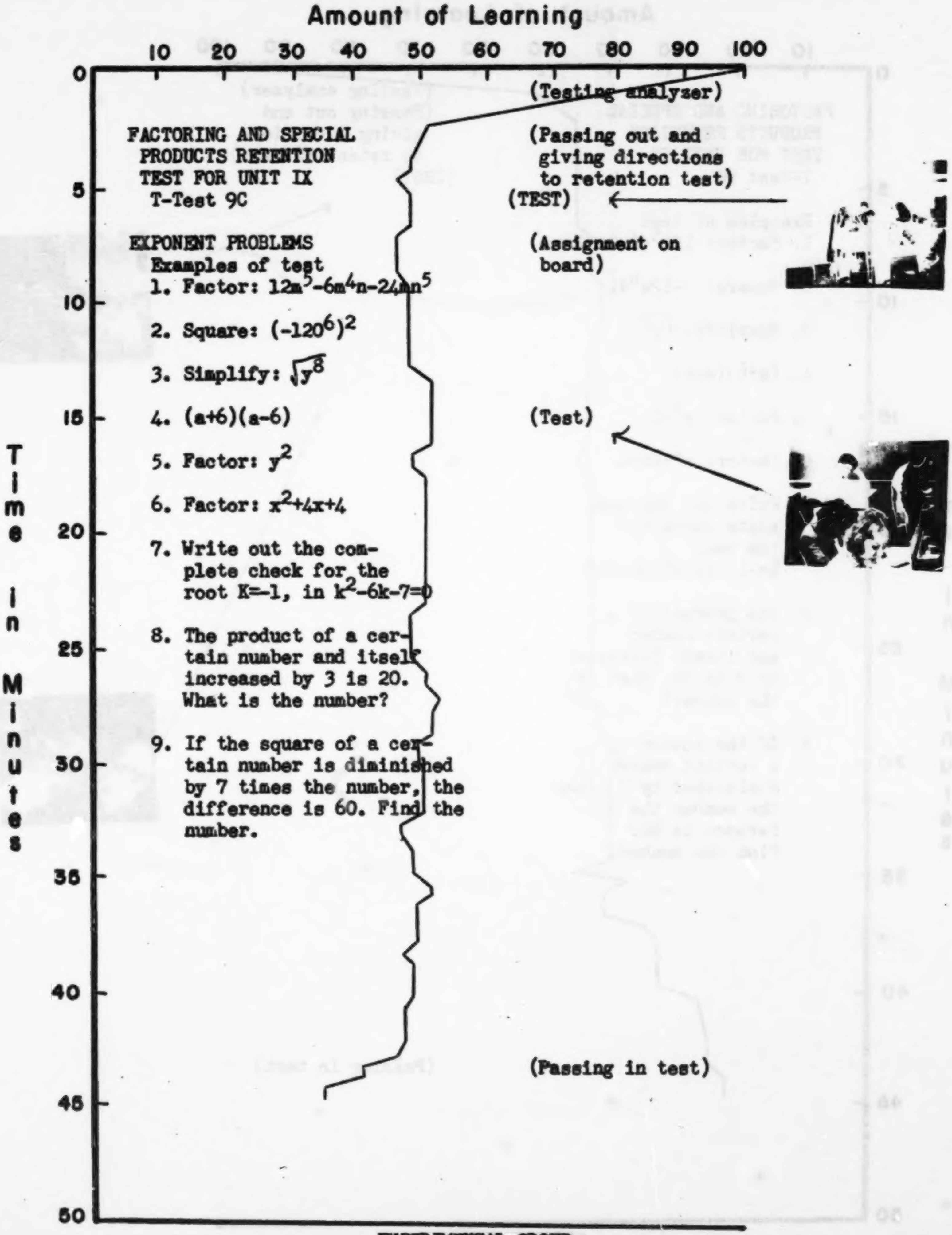

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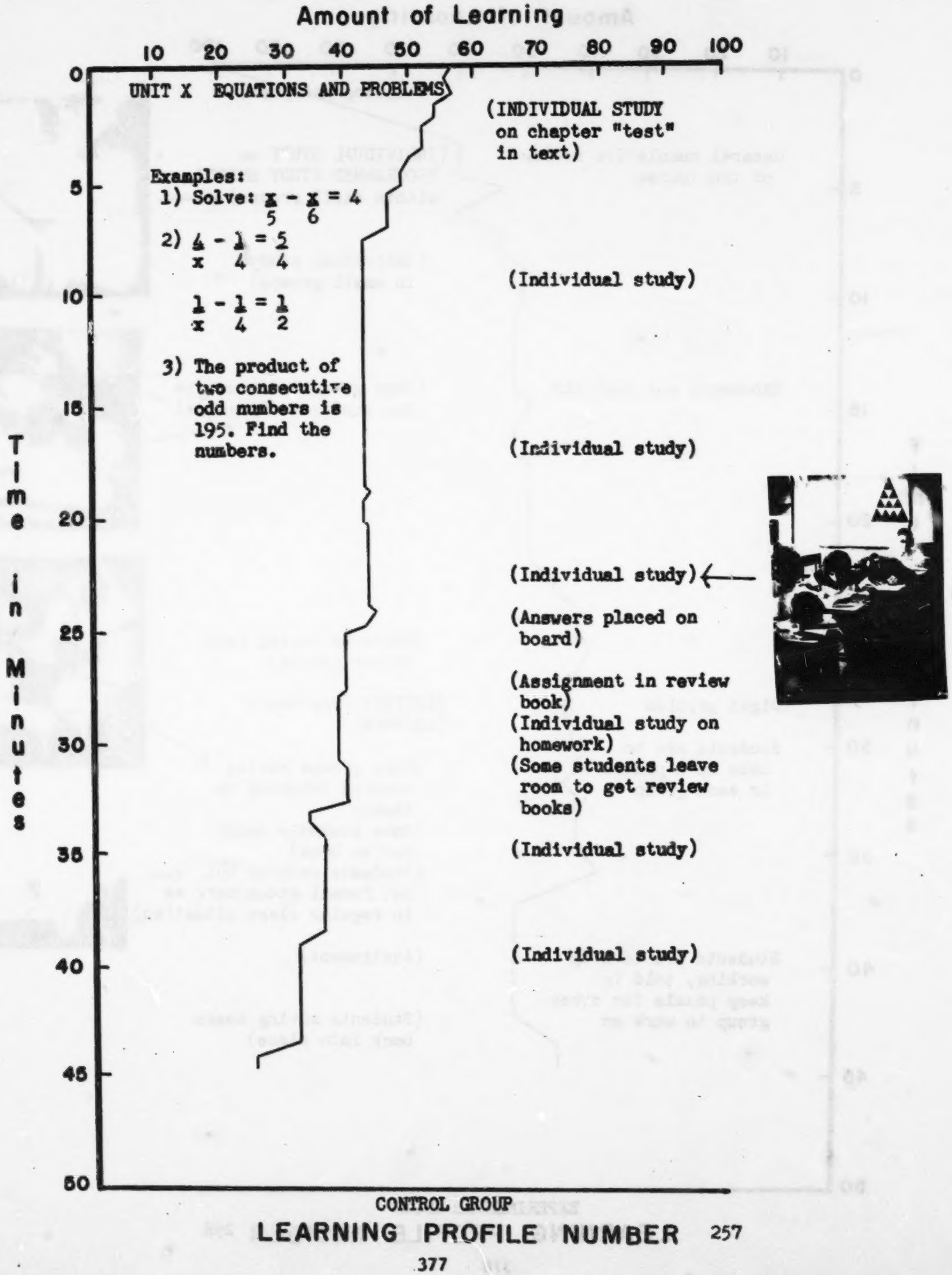

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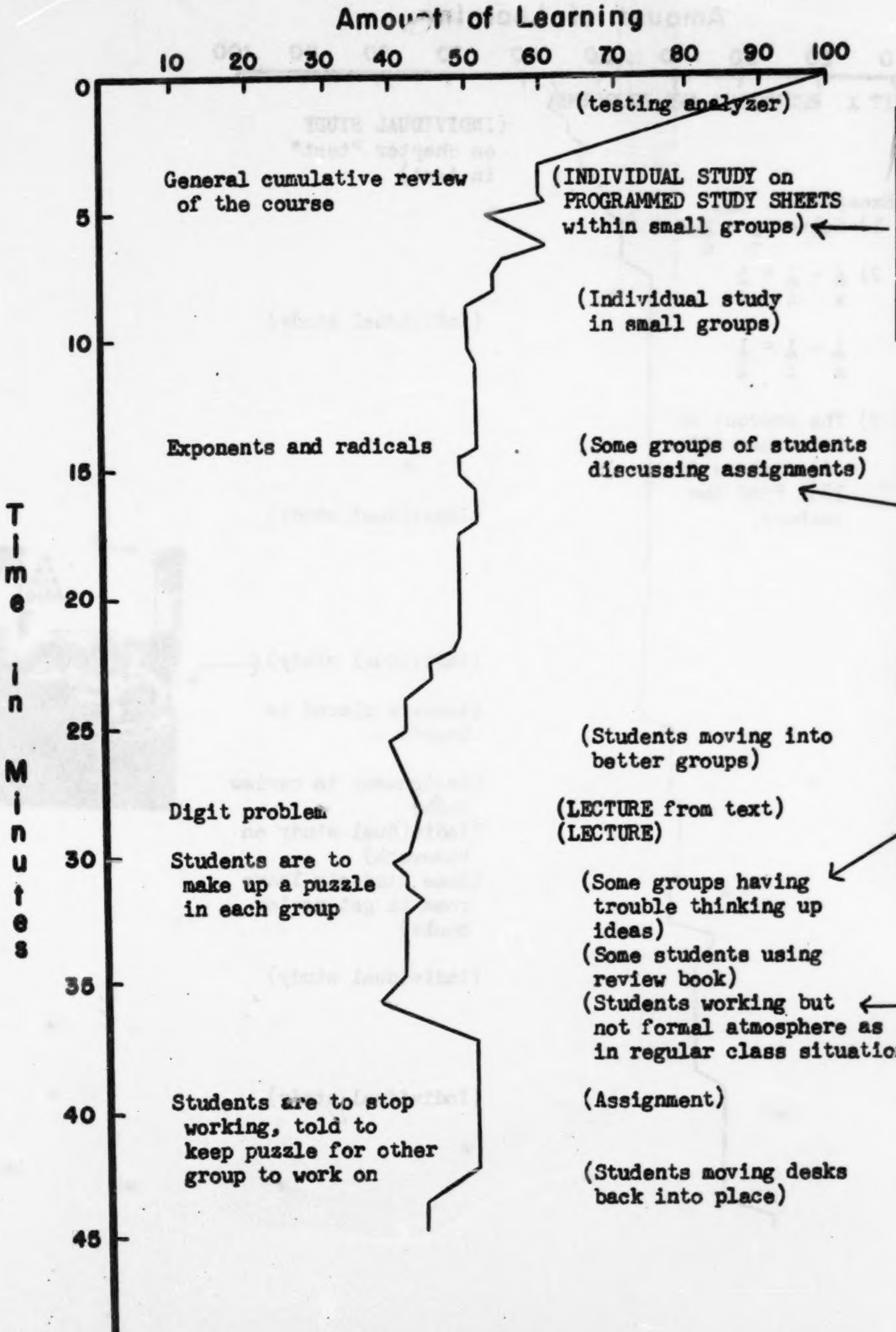

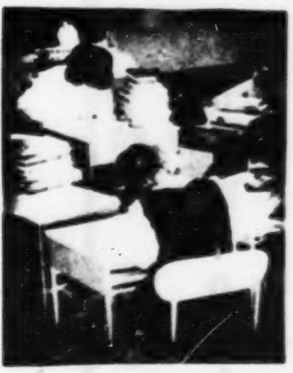

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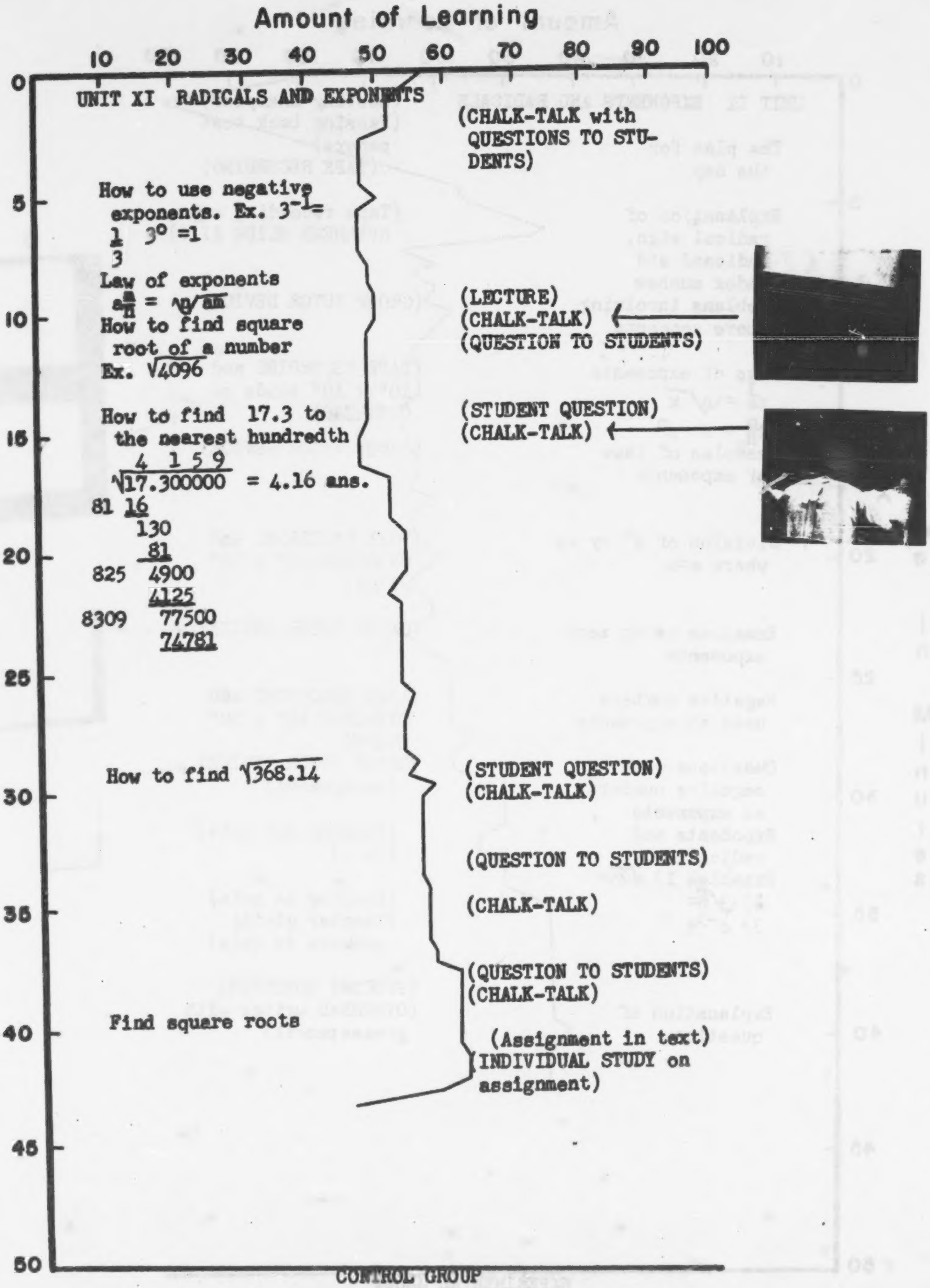

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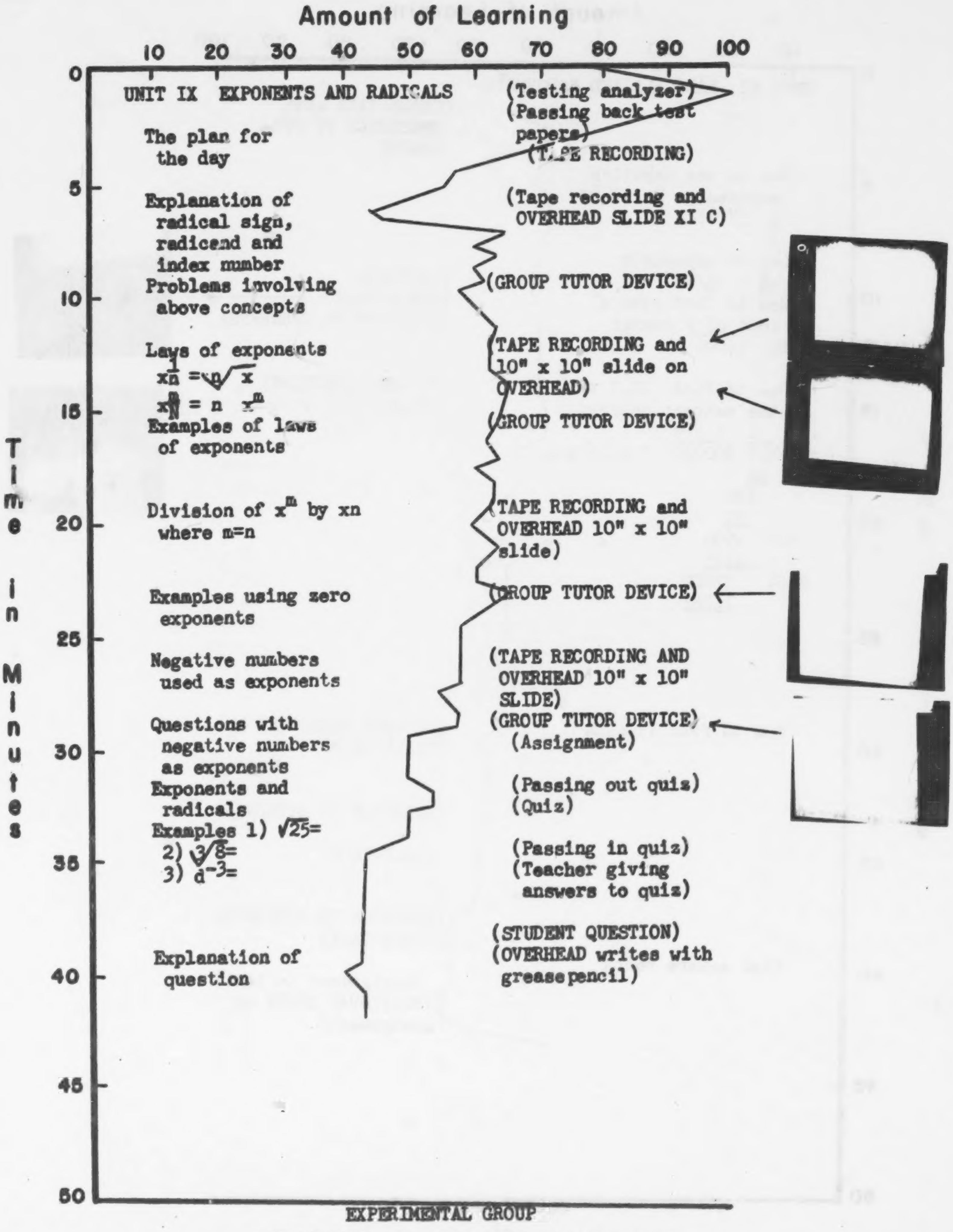

EXPERIMENTAL GROUP

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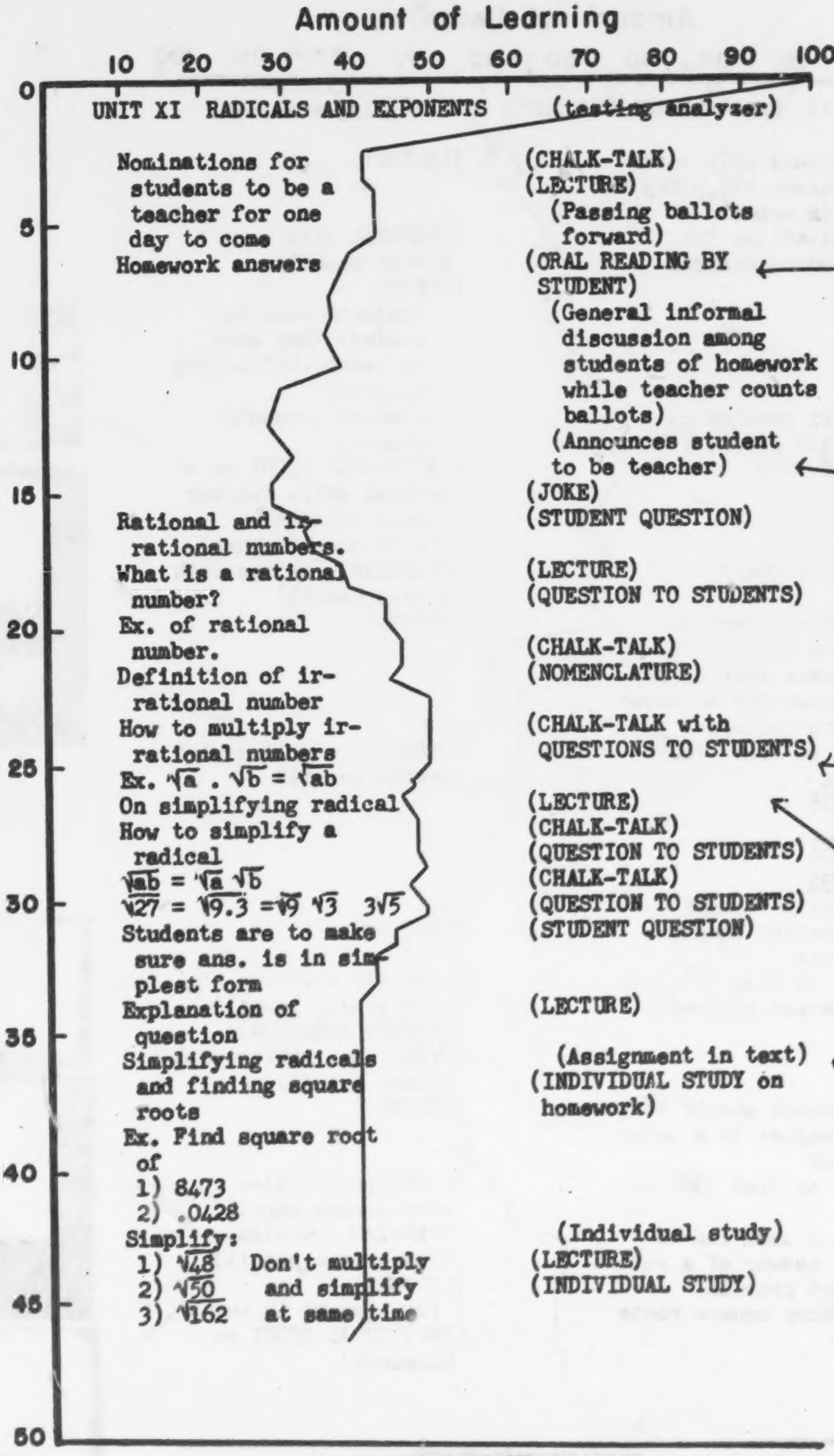

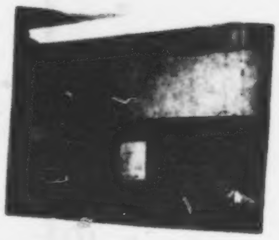

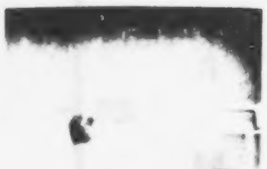

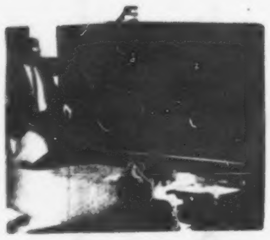

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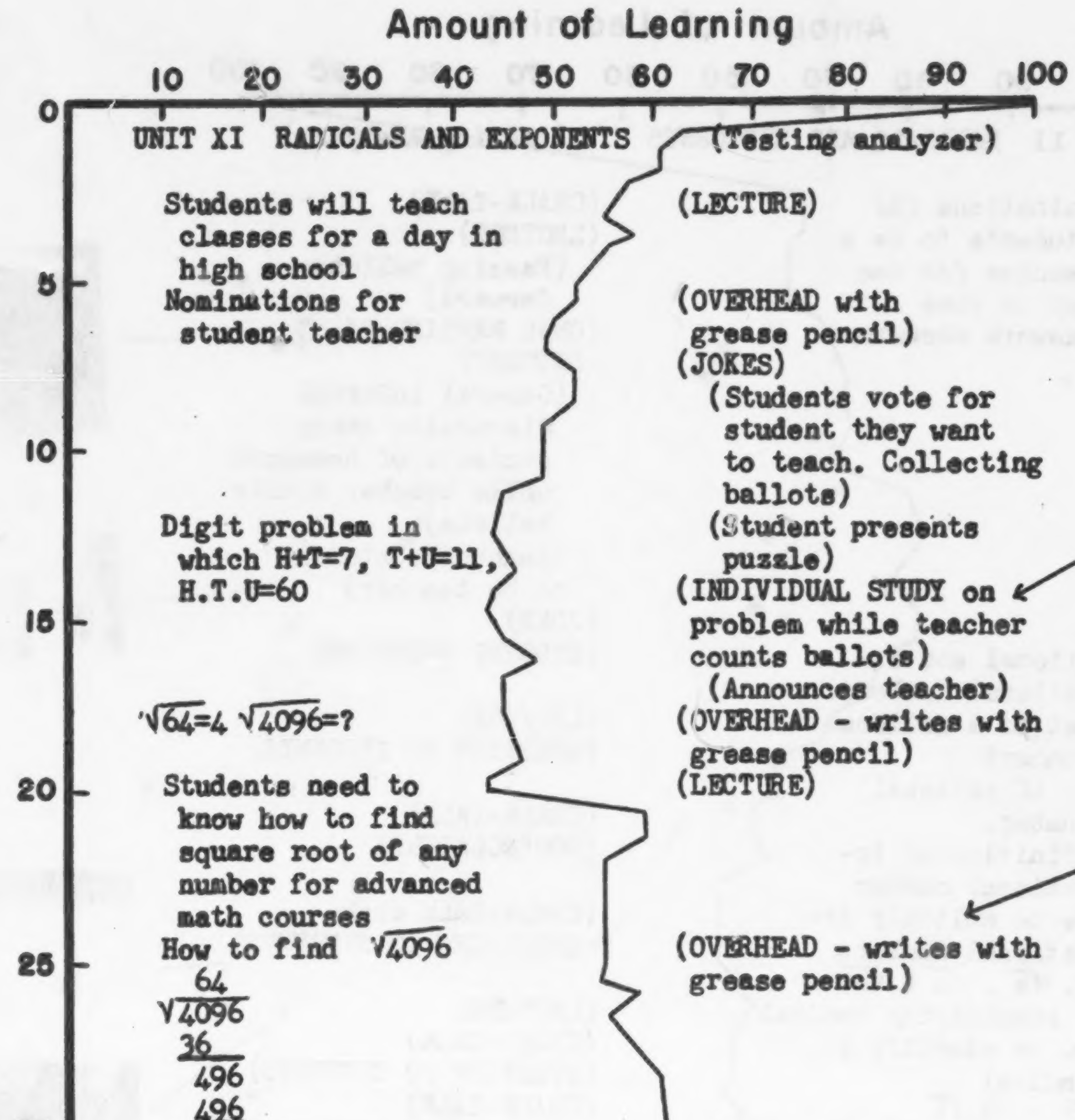


UNIT XI RADICALS AND EXPONENTS

(Testing analyzer)

Students will teach classes for a day in high school

Nominations for student teacher

Digit problem in which H+T=7, T+U=11, H.T.U=60

$\sqrt{64}=4$ $\sqrt{4096}=?$

Students need to know how to find square root of any number for advanced math courses

How to find $\sqrt{4096}$

$$\begin{array}{r} 64 \\ \sqrt{4096} \\ \underline{36} \\ 496 \\ \underline{496} \end{array}$$

Checking answer

On harder square roots

How to find $\sqrt{17.3}$ to nearest hundredth

Students should keep examples in a notebook

How to find $\sqrt{386.14}$

How a zero can be in answer of a square root problem

Finding square roots

(LECTURE)

(OVERHEAD with grease pencil)

(JOKES)

(Students vote for student they want to teach. Collecting ballots)

(Student presents puzzle)

(INDIVIDUAL STUDY on problem while teacher counts ballots)

(Announces teacher)

(OVERHEAD - writes with grease pencil)

(LECTURE)

(OVERHEAD - writes with grease pencil)

(LECTURE)

(OVERHEAD - writes with grease pencil)

(STUDENT QUESTION)

(OVERHEAD - writes with grease pencil)

(LECTURE)

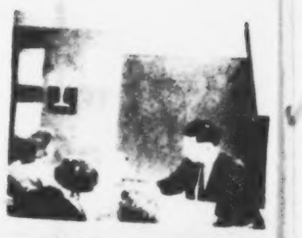
(OVERHEAD - writes with grease pencil)

(OVERHEAD - writes with grease pencil)

(LECTURE)

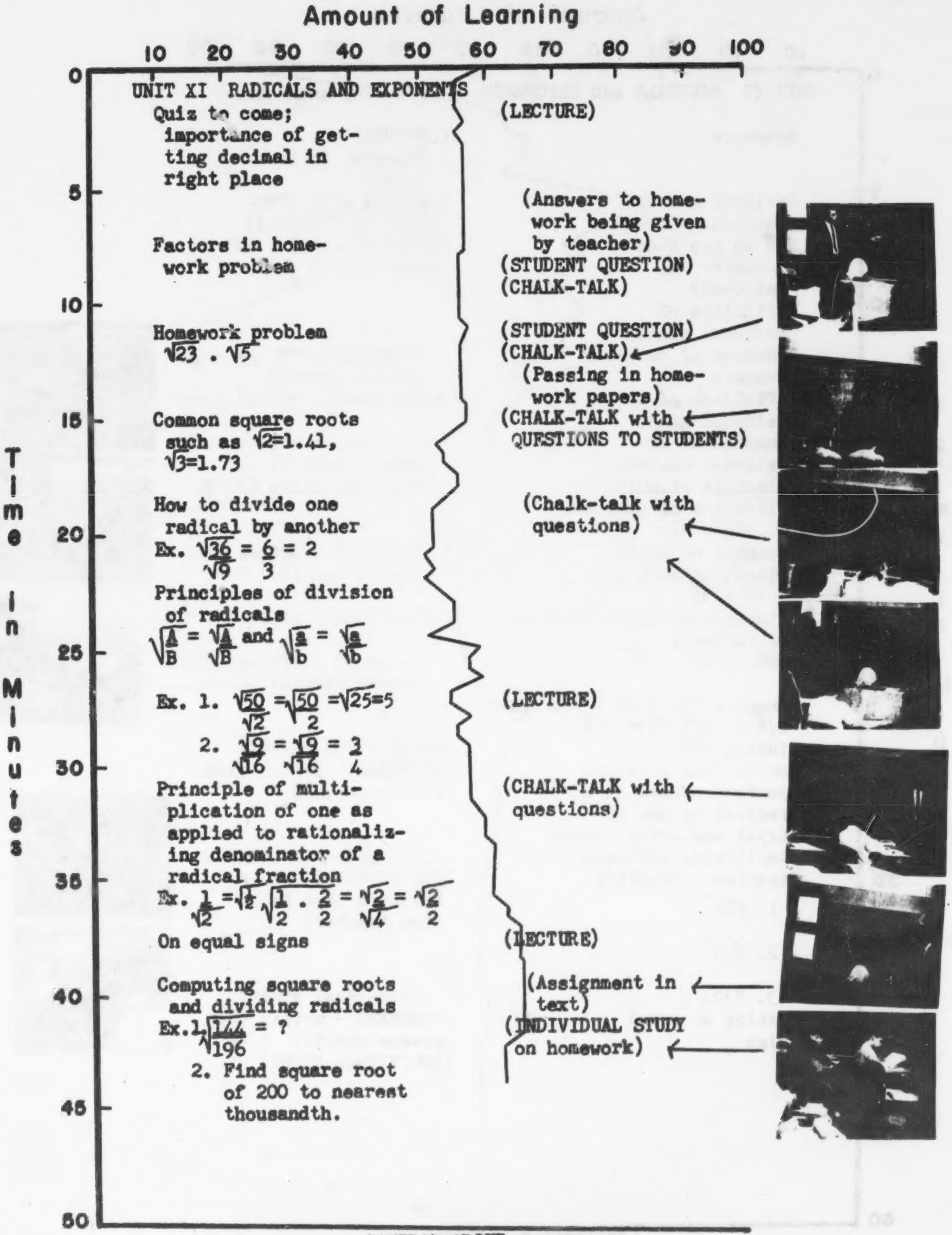
(Assignment in text)

(INDIVIDUAL STUDY on homework)



EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 262



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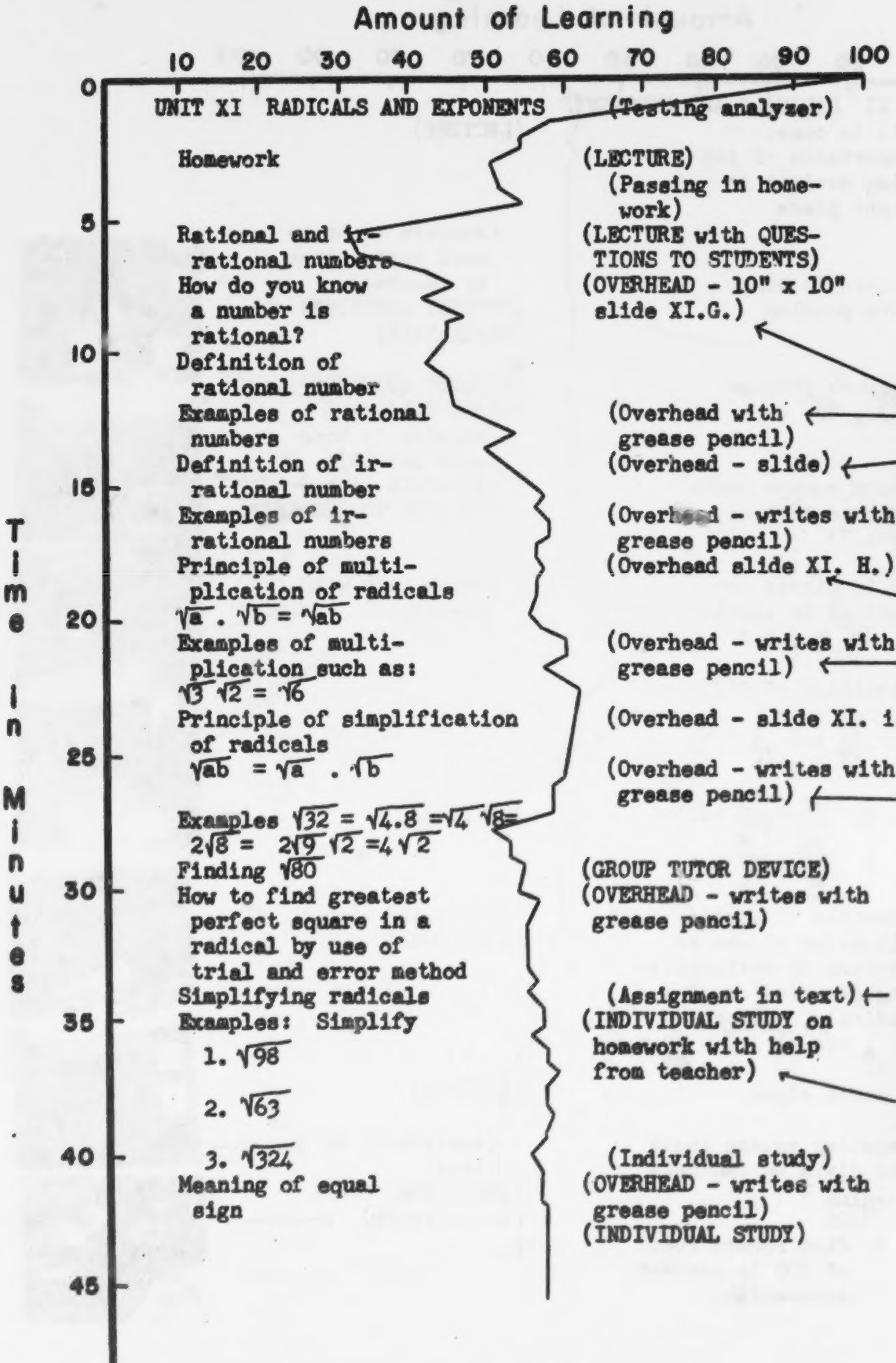


UNIT XI RADICALS AND EXPONENTS (Testing analyzer)

Homework (LECTURE)

(Passing in homework)

Rational and irrational numbers (LECTURE with QUESTIONS TO STUDENTS)

How do you know a number is rational? (OVERHEAD - 10" x 10" slide XI.G.)

Definition of rational number

Examples of rational numbers (Overhead with grease pencil)

Definition of irrational number (Overhead - slide)

Examples of irrational numbers (Overhead - writes with grease pencil)

Principle of multiplication of radicals (Overhead slide XI. H.)

$\sqrt{a} \cdot \sqrt{b} = \sqrt{ab}$

Examples of multiplication such as: (Overhead - writes with grease pencil)

$\sqrt{3}\,\sqrt{2} = \sqrt{6}$

Principle of simplification of radicals (Overhead - slide XI. i.)

$\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$ (Overhead - writes with grease pencil)

Examples $\sqrt{32} = \sqrt{4.8} = \sqrt{4}\,\sqrt{8} = 2\sqrt{8} = 2\sqrt{9}\,\sqrt{2} = 4\sqrt{2}$

Finding $\sqrt{80}$ (GROUP TUTOR DEVICE)

How to find greatest perfect square in a radical by use of trial and error method (OVERHEAD - writes with grease pencil)

Simplifying radicals (Assignment in text)

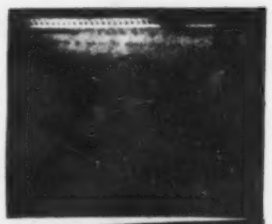
Examples: Simplify (INDIVIDUAL STUDY on homework with help from teacher)

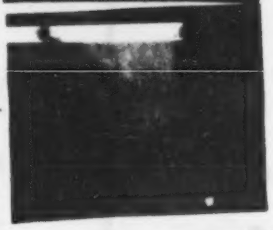
1. $\sqrt{98}$
2. $\sqrt{63}$
3. $\sqrt{324}$

(Individual study)

Meaning of equal sign (OVERHEAD - writes with grease pencil)

(INDIVIDUAL STUDY)





EXPERIMENTAL GROUP

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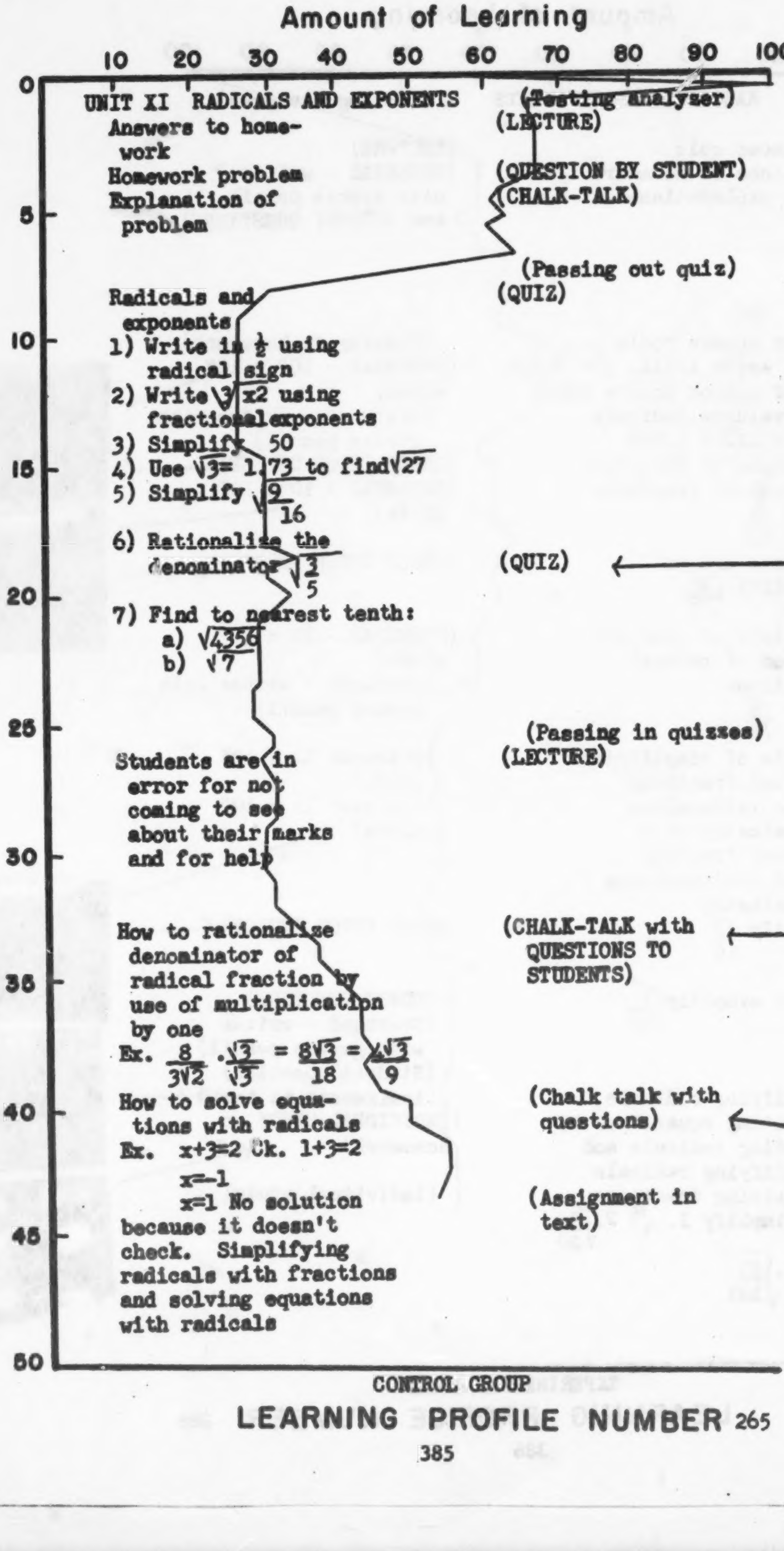

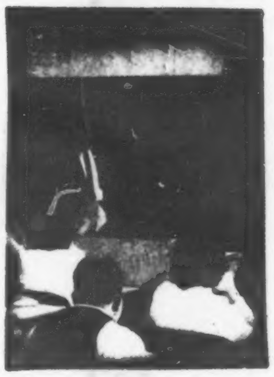

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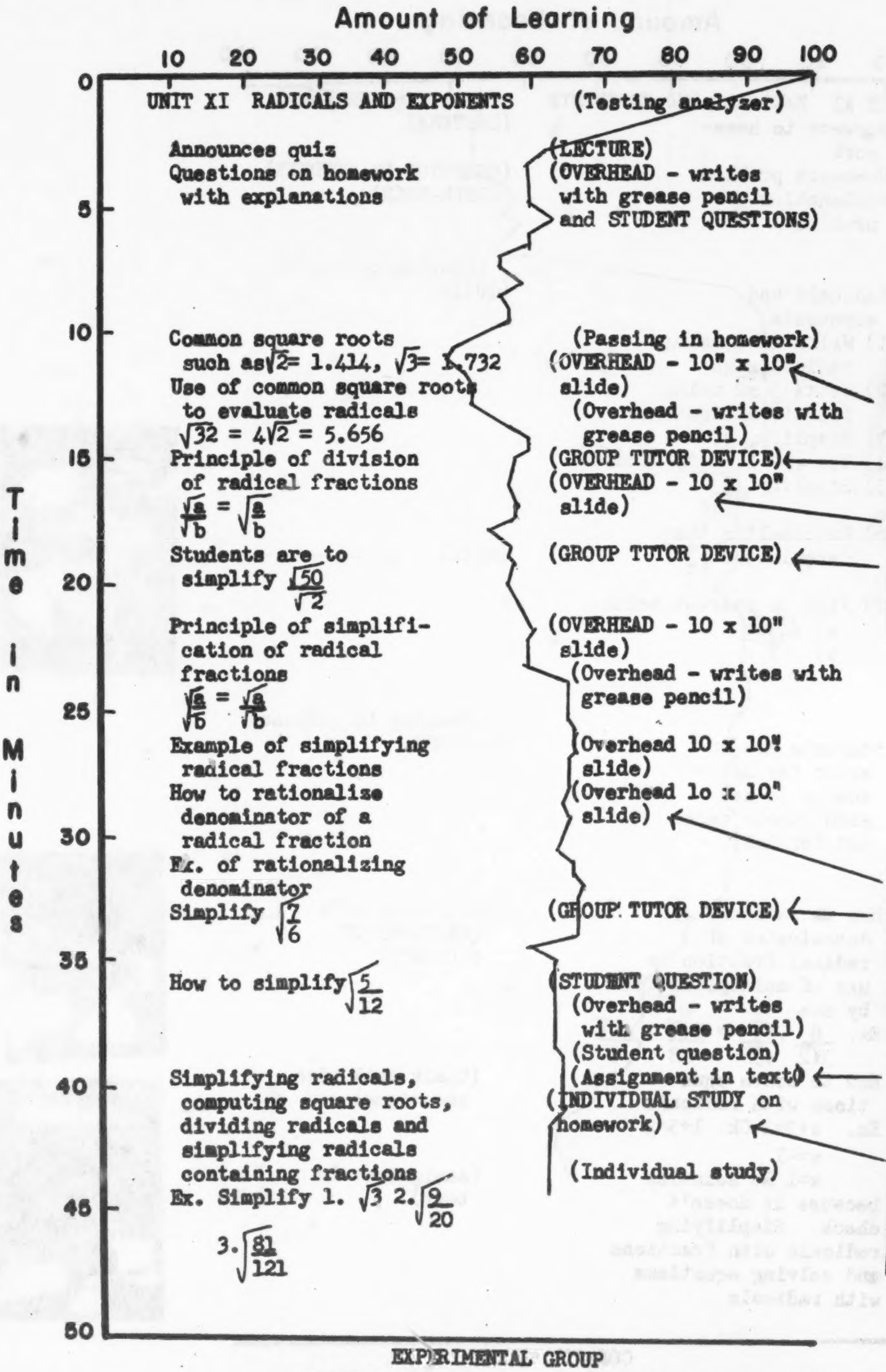


UNIT XI RADICALS AND EXPONENTS (Testing analyzer)

Announces quiz (LECTURE)
Questions on homework with explanations (OVERHEAD - writes with grease pencil and STUDENT QUESTIONS)

Common square roots such as $\sqrt{2} = 1.414$, $\sqrt{3} = 1.732$ (Passing in homework) (OVERHEAD - 10" x 10" slide)
Use of common square roots to evaluate radicals $\sqrt{32} = 4\sqrt{2} = 5.656$ (Overhead - writes with grease pencil)

Principle of division of radical fractions $\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$ (GROUP TUTOR DEVICE) (OVERHEAD - 10 x 10" slide)

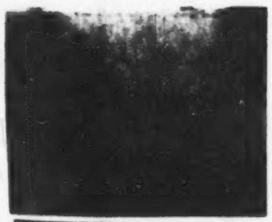
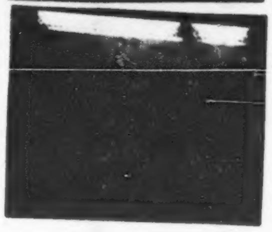
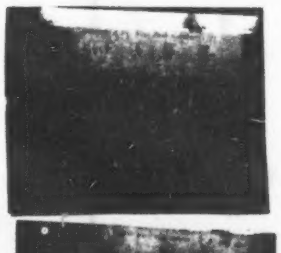
Students are to simplify $\frac{\sqrt{50}}{\sqrt{2}}$ (GROUP TUTOR DEVICE)

Principle of simplification of radical fractions $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$ (OVERHEAD - 10 x 10" slide) (Overhead - writes with grease pencil)

Example of simplifying radical fractions (Overhead 10 x 10" slide)
How to rationalize denominator of a radical fraction (Overhead 10 x 10" slide)
Ex. of rationalizing denominator
Simplify $\sqrt{\frac{7}{6}}$ (GROUP TUTOR DEVICE)

How to simplify $\sqrt{\frac{5}{12}}$ (STUDENT QUESTION) (Overhead - writes with grease pencil) (Student question)

Simplifying radicals, computing square roots, dividing radicals and simplifying radicals containing fractions (Assignment in text) (INDIVIDUAL STUDY on homework) (Individual study)
Ex. Simplify 1. $\sqrt{3}$ 2. $\sqrt{\frac{9}{20}}$ 3. $\sqrt{\frac{81}{121}}$

EXPERIMENTAL GROUP

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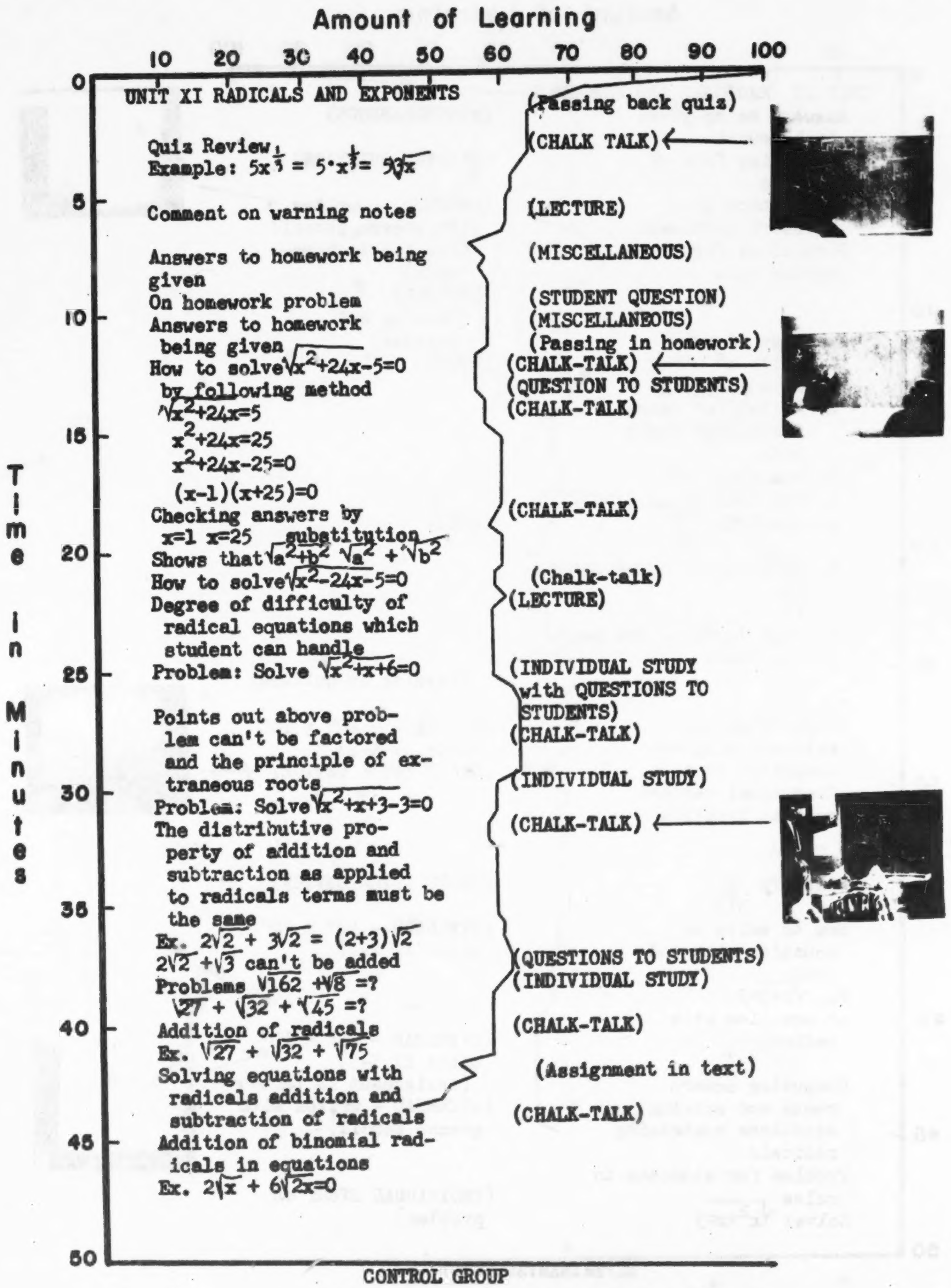

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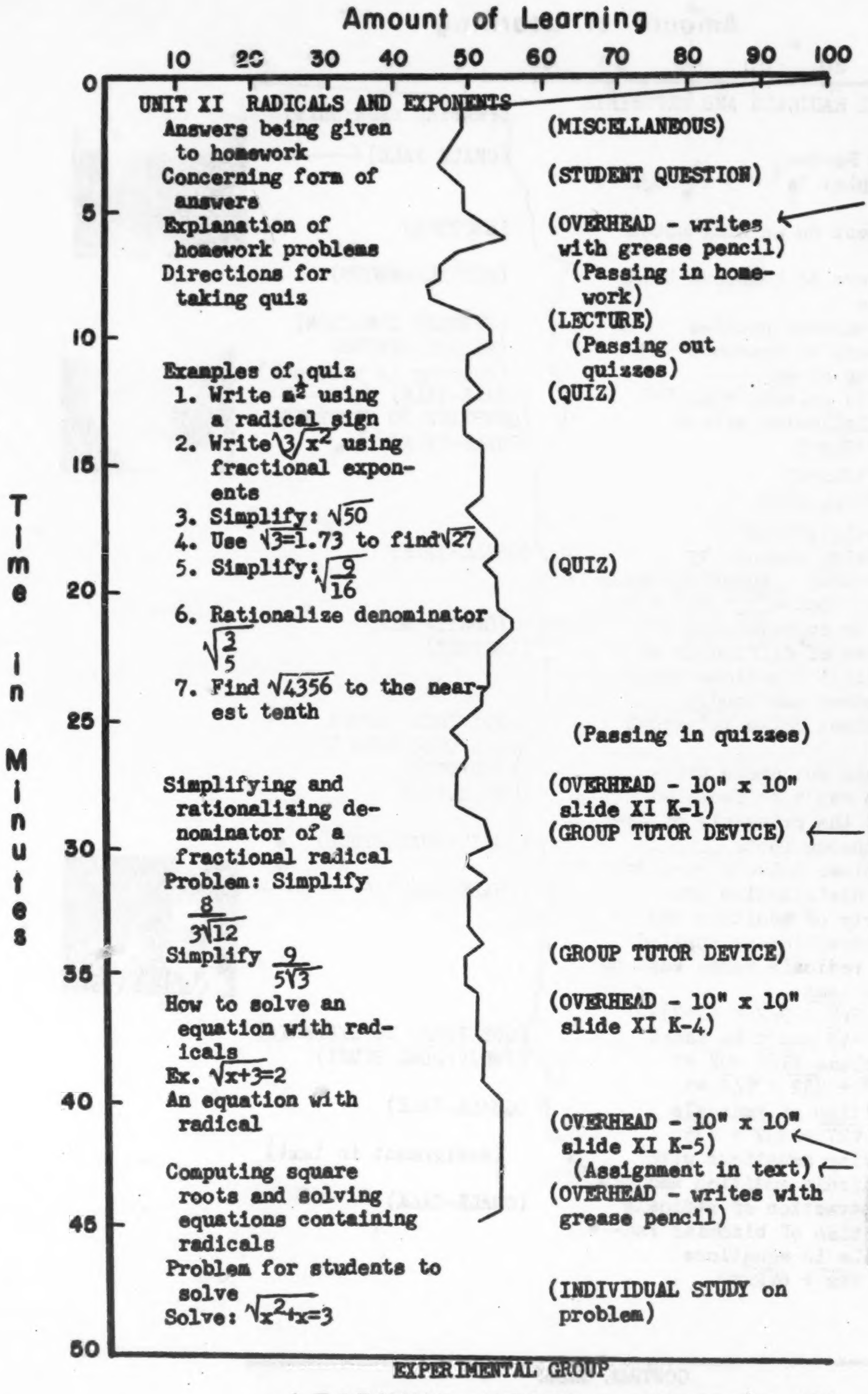

EXPERIMENTAL GROUP

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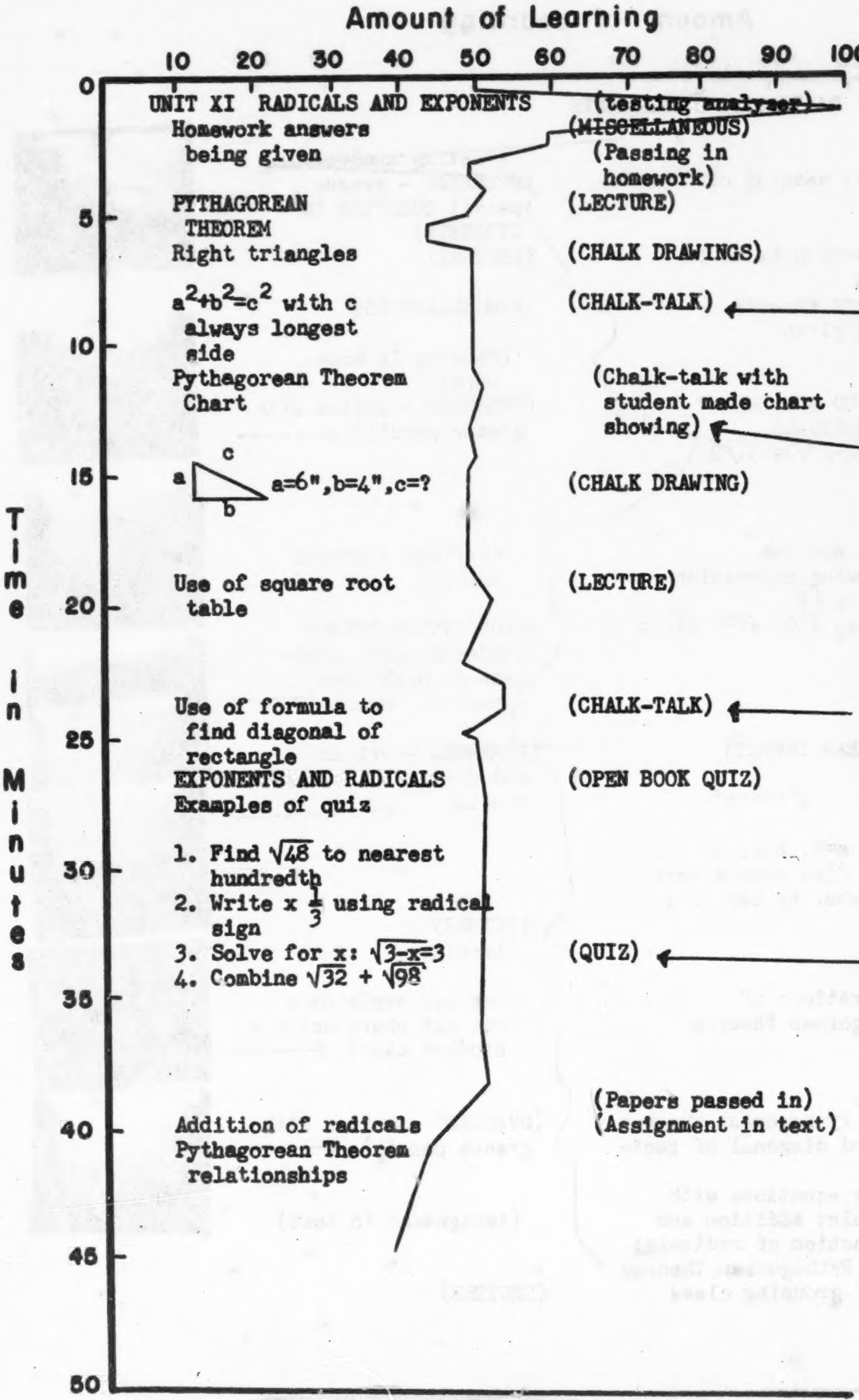

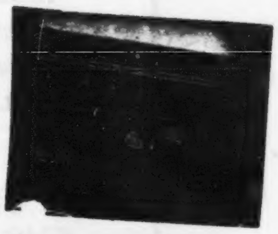

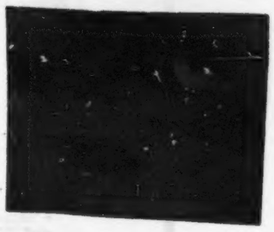

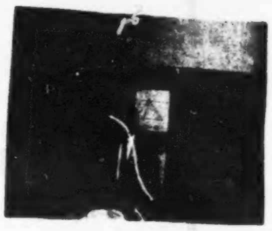

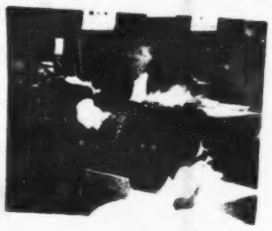

CONTROL GROUP

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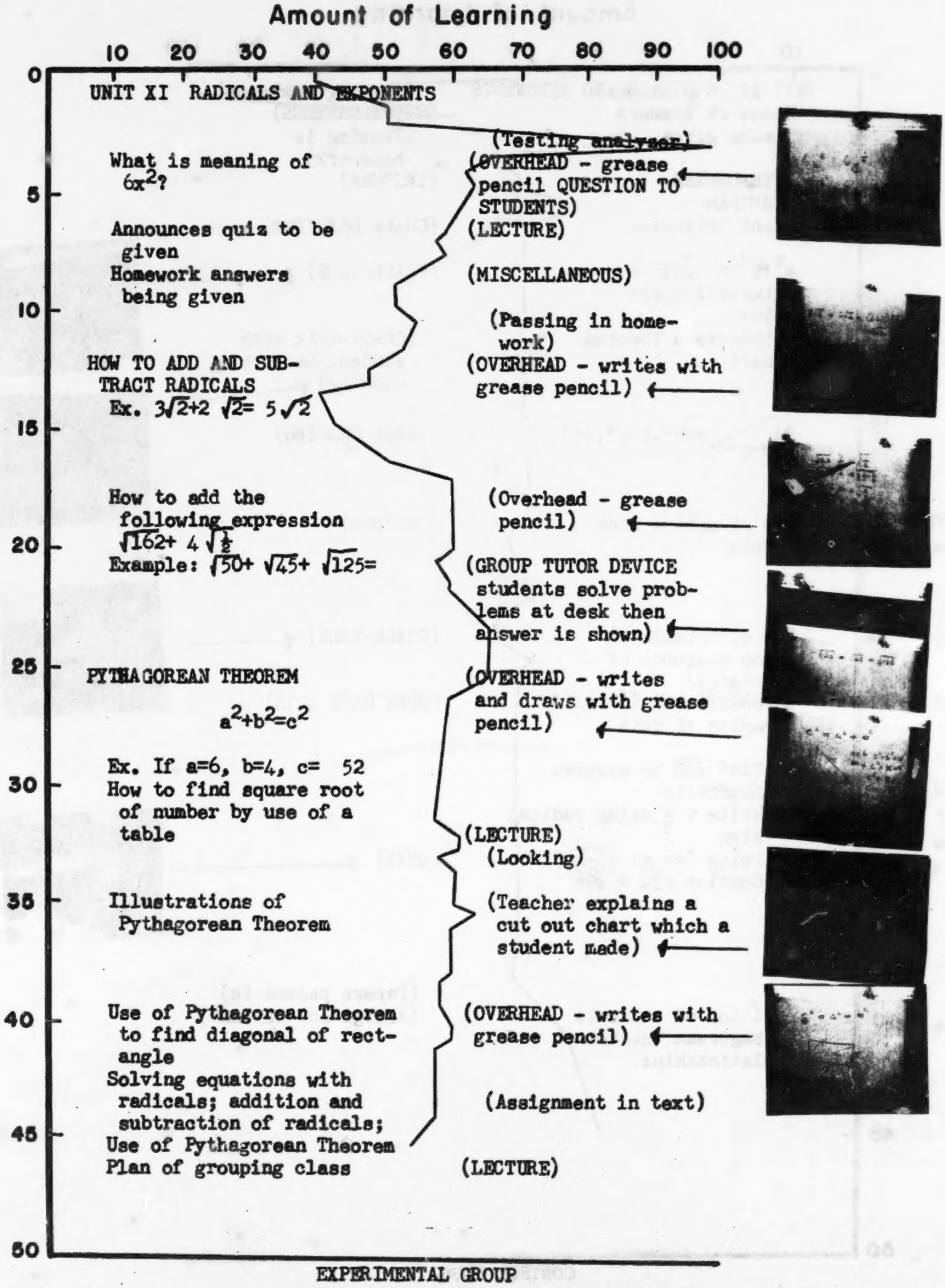

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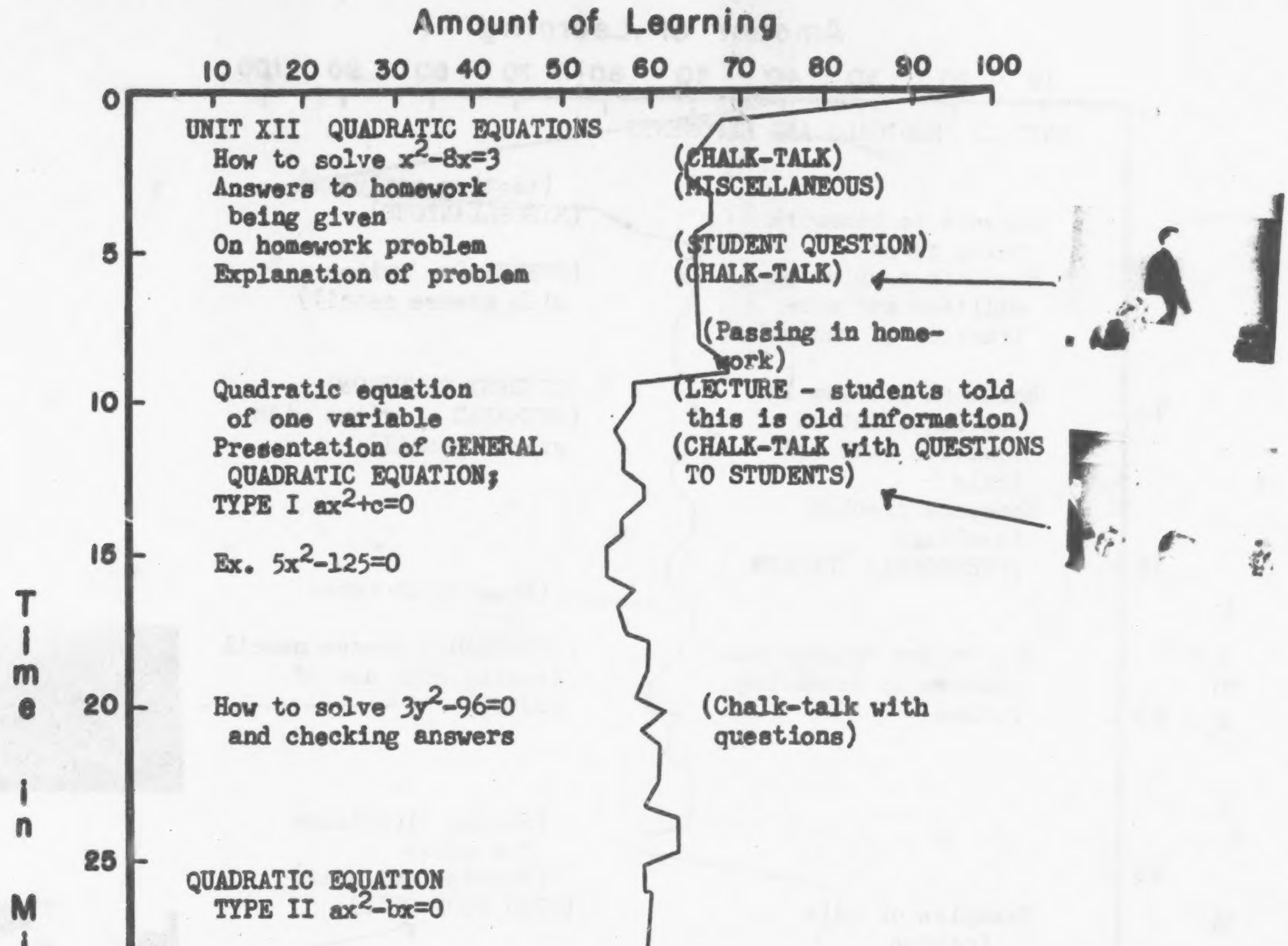

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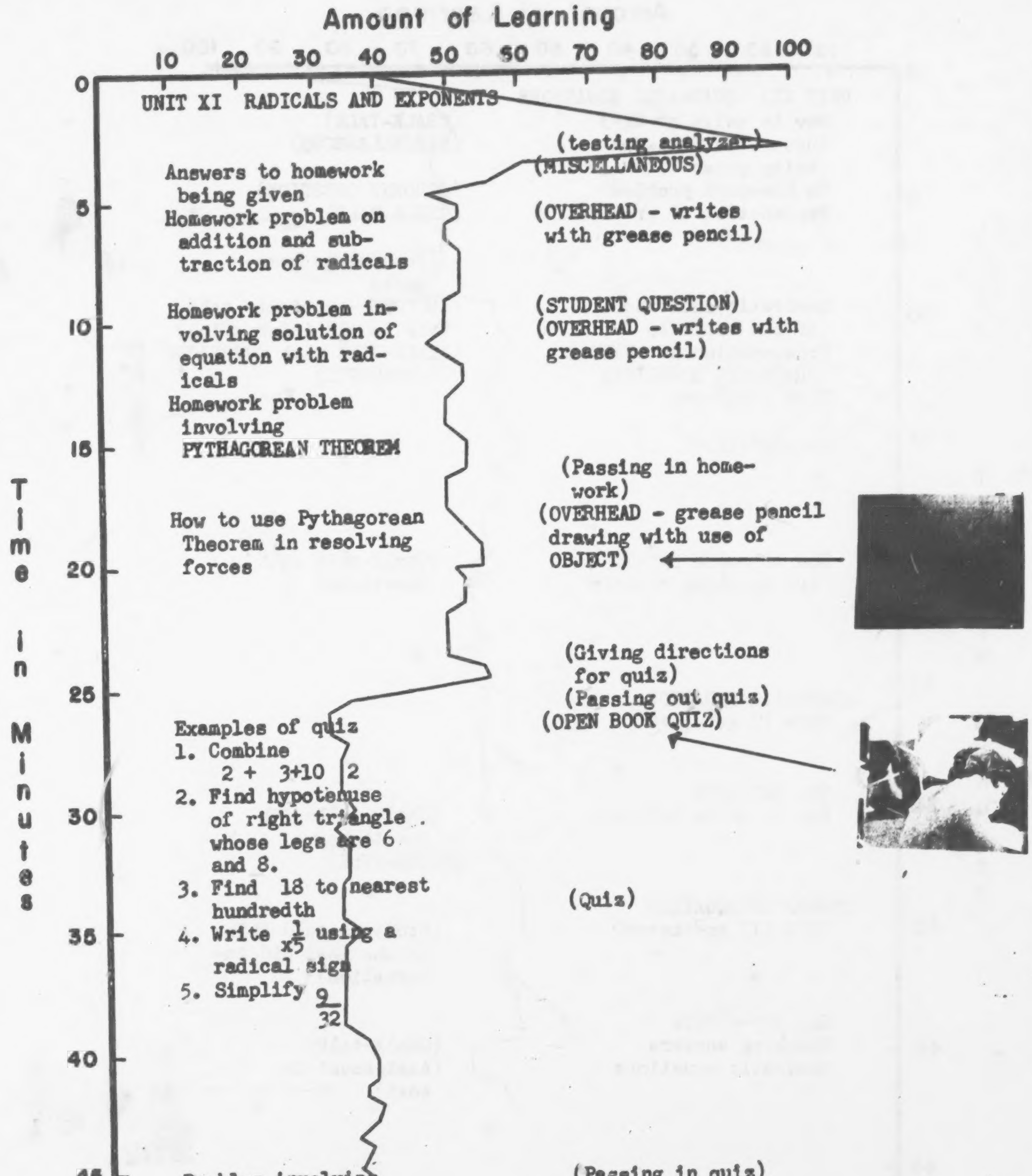

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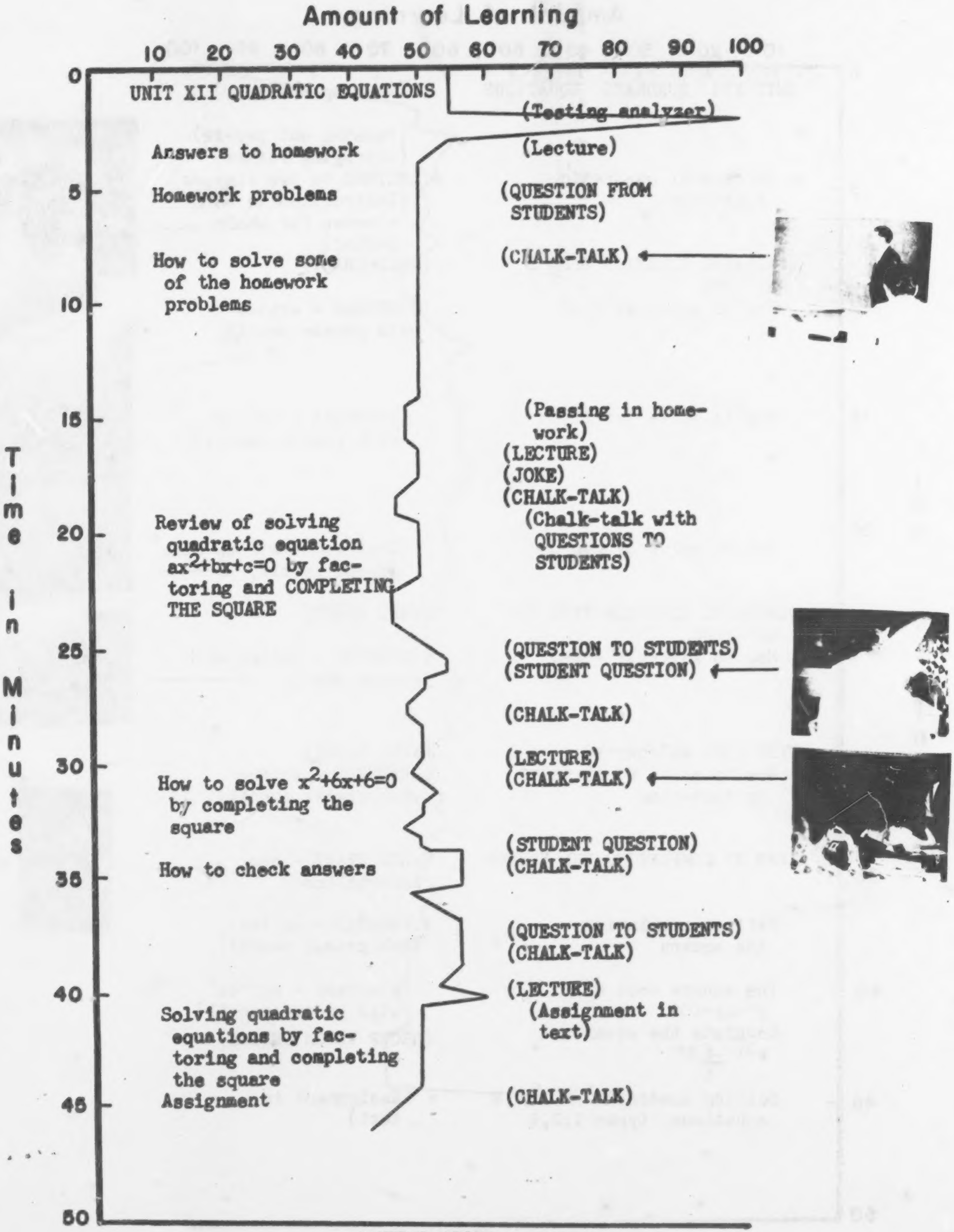

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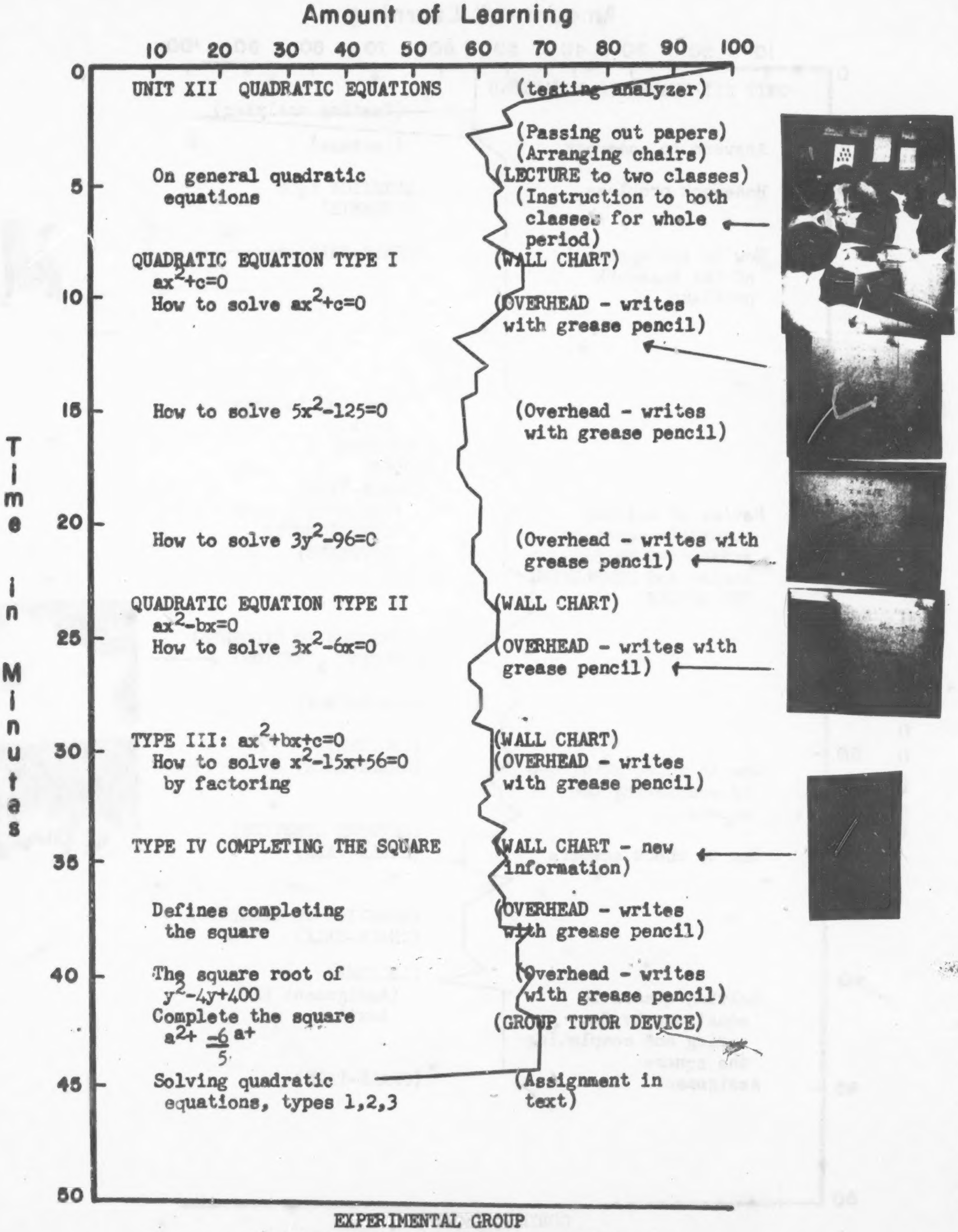

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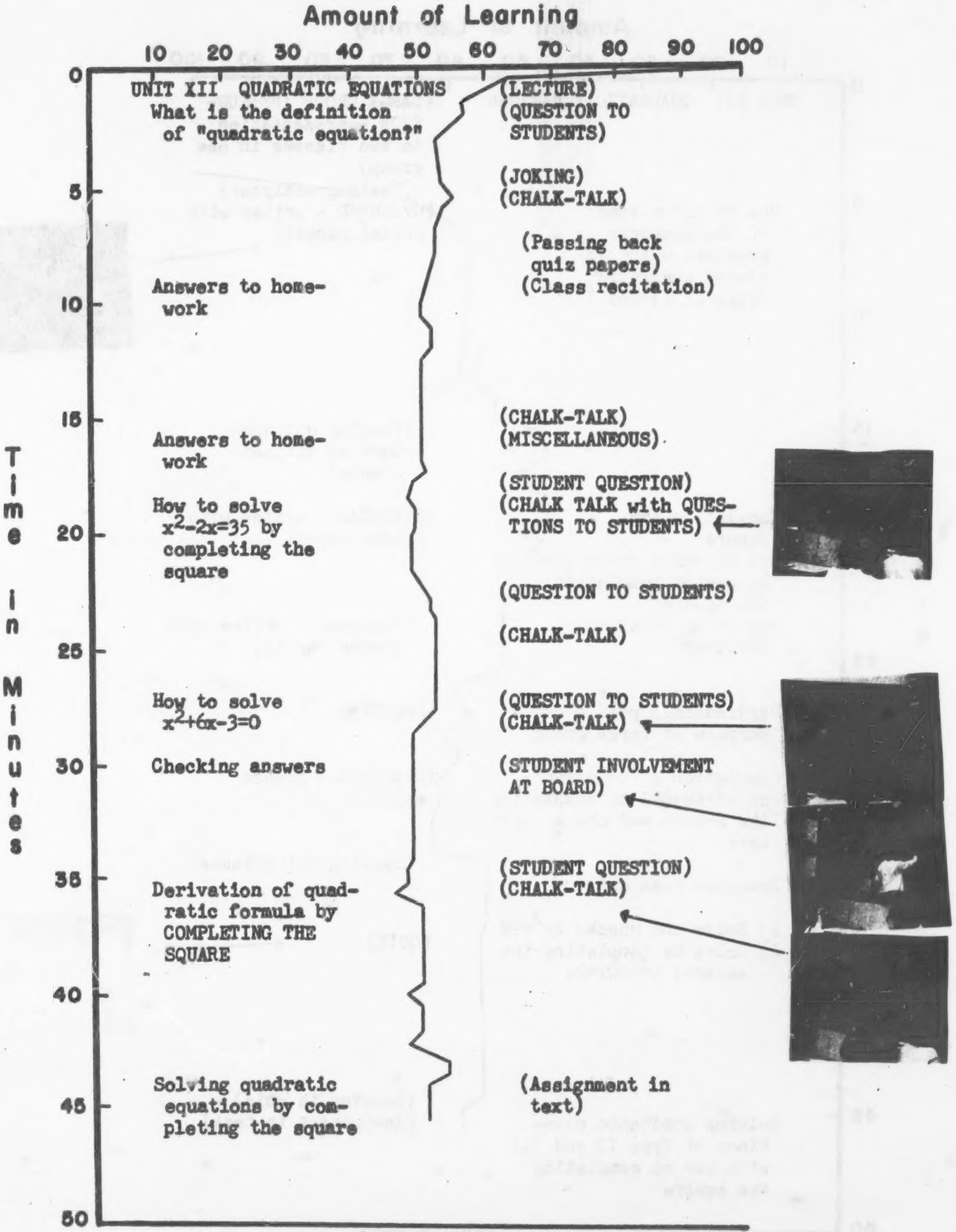

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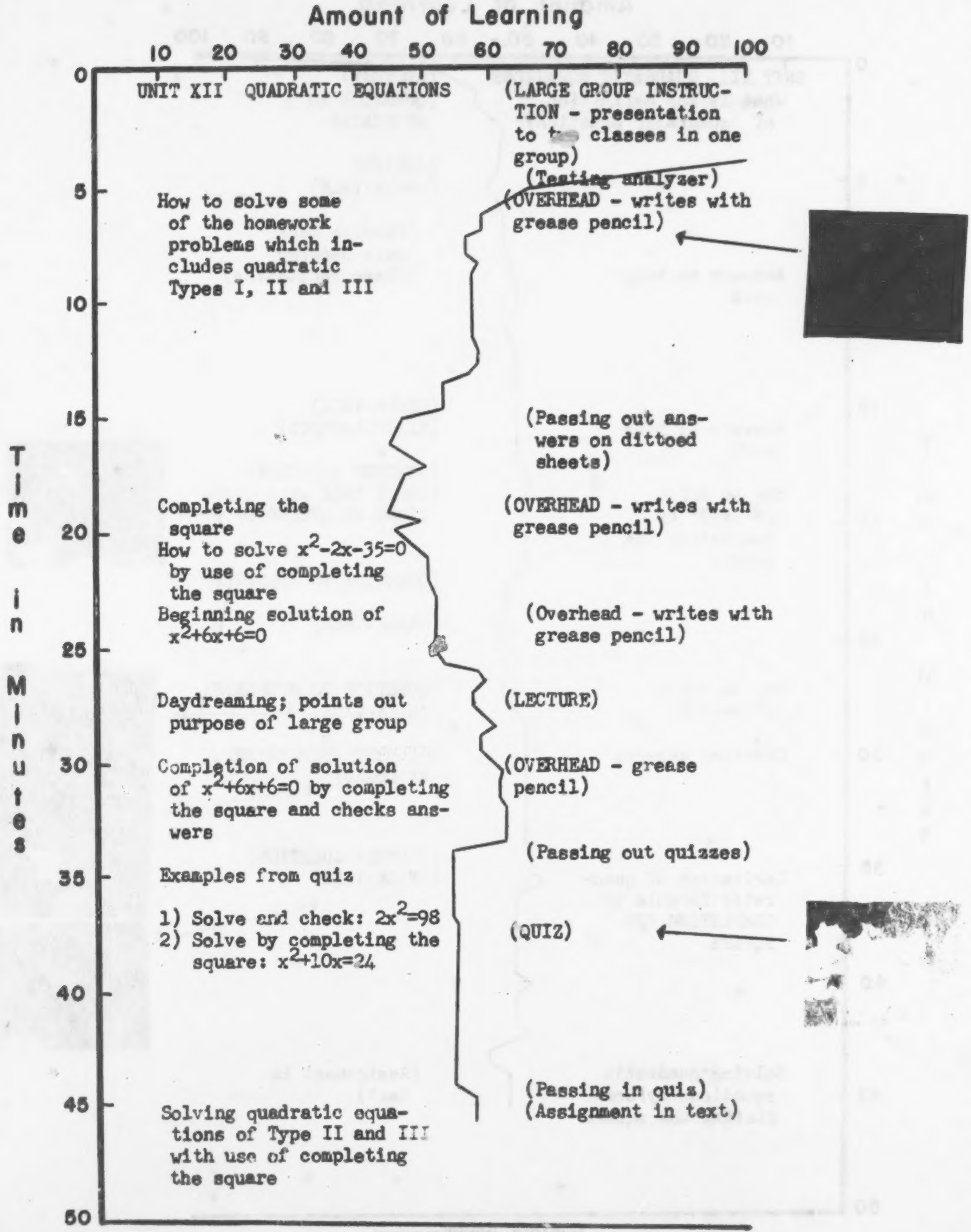

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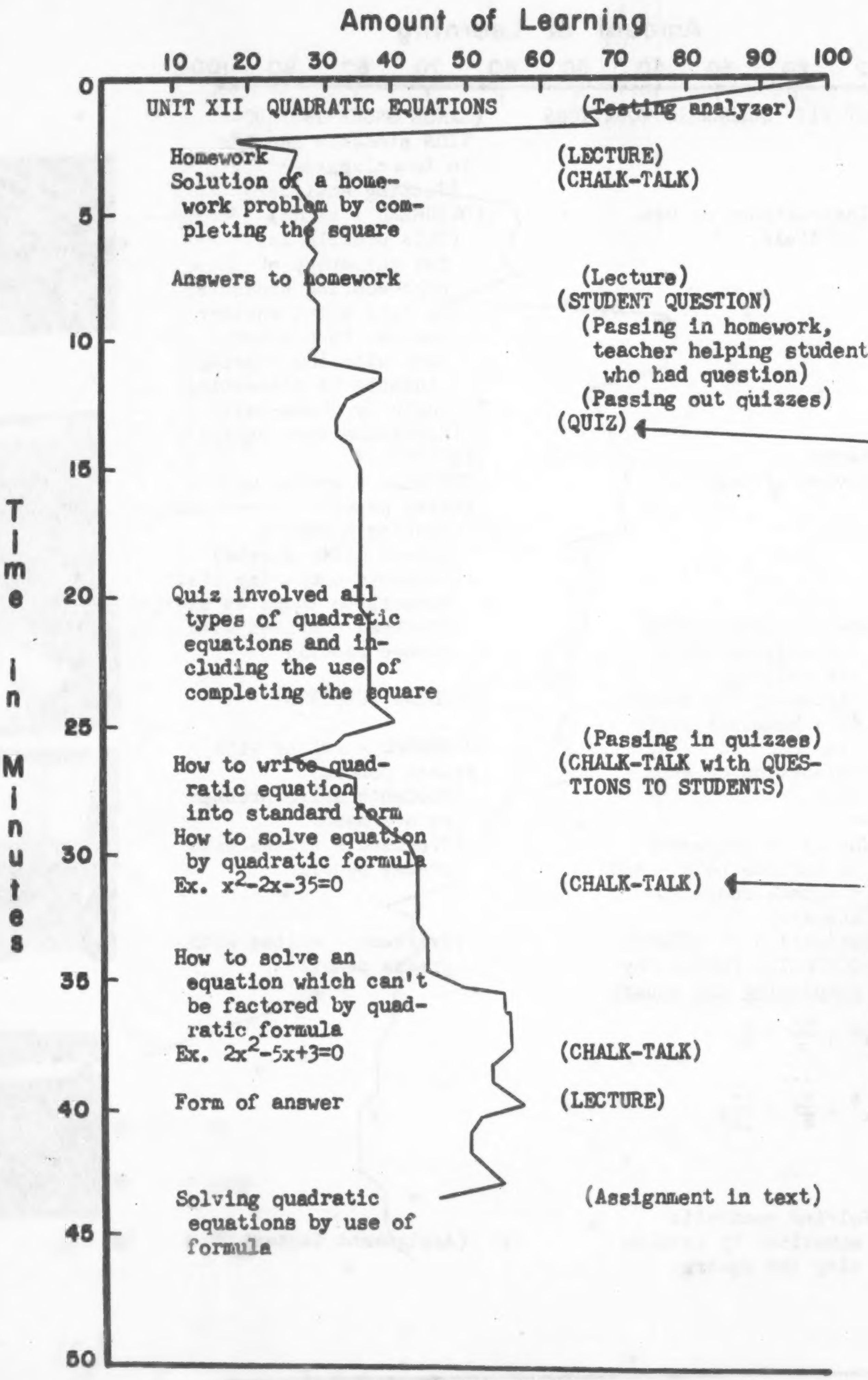

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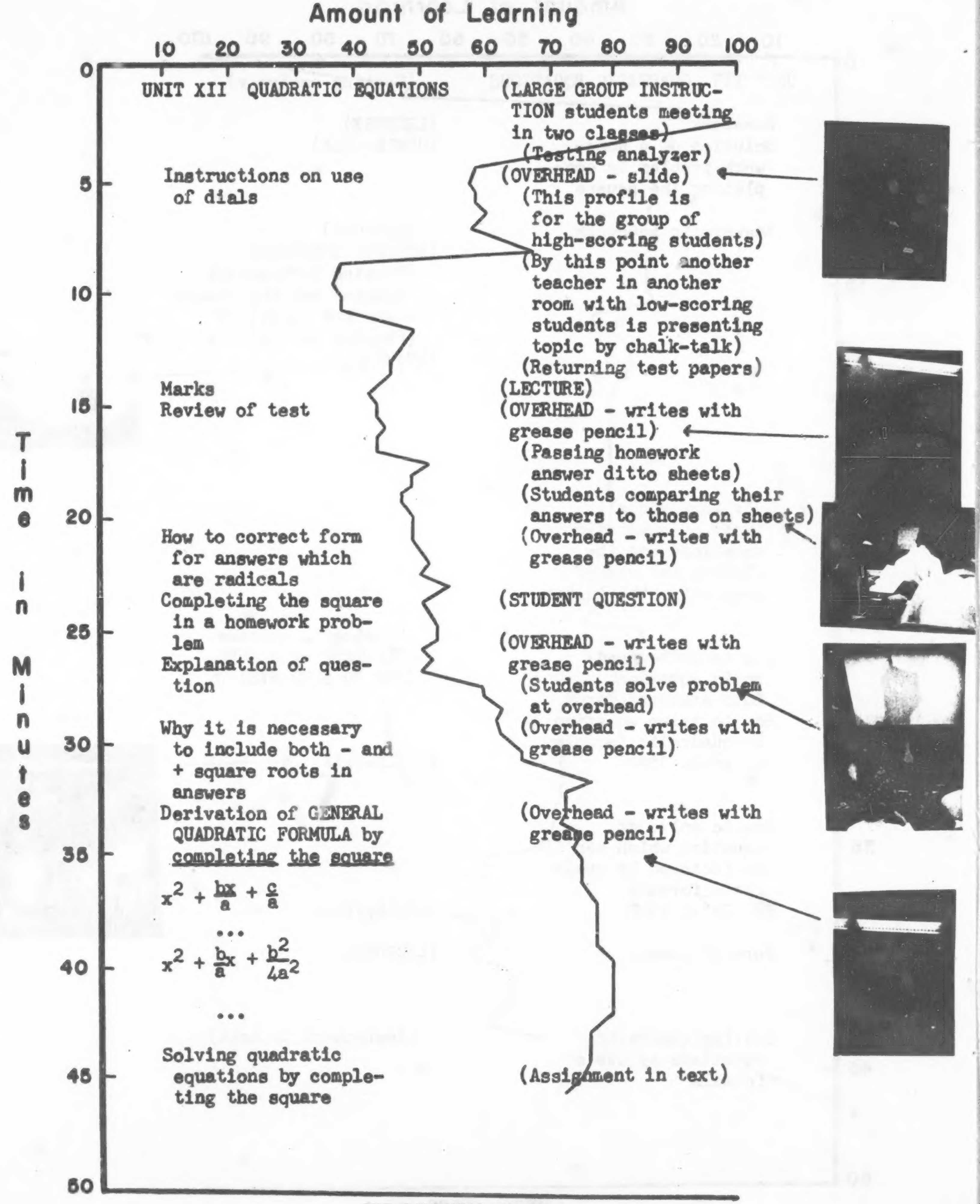


UNIT XII QUADRATIC EQUATIONS

(LARGE GROUP INSTRUCTION students meeting in two classes)

(Testing analyzer)

Instructions on use of dials

(OVERHEAD - slide)

(This profile is for the group of high-scoring students)

(By this point another teacher in another room with low-scoring students is presenting topic by chalk-talk)

(Returning test papers)

Marks

(LECTURE)

Review of test

(OVERHEAD - writes with grease pencil)

(Passing homework answer ditto sheets)

(Students comparing their answers to those on sheets)

How to correct form for answers which are radicals

(Overhead - writes with grease pencil)

Completing the square in a homework problem

(STUDENT QUESTION)

(OVERHEAD - writes with grease pencil)

Explanation of question

(Students solve problem at overhead)

Why it is necessary to include both - and + square roots in answers

(Overhead - writes with grease pencil)

Derivation of GENERAL QUADRATIC FORMULA by completing the square

(Overhead - writes with grease pencil)

$x^2 + \frac{bx}{a} + \frac{c}{a}$

...

$x^2 + \frac{b}{a}x + \frac{b^2}{4a^2}$

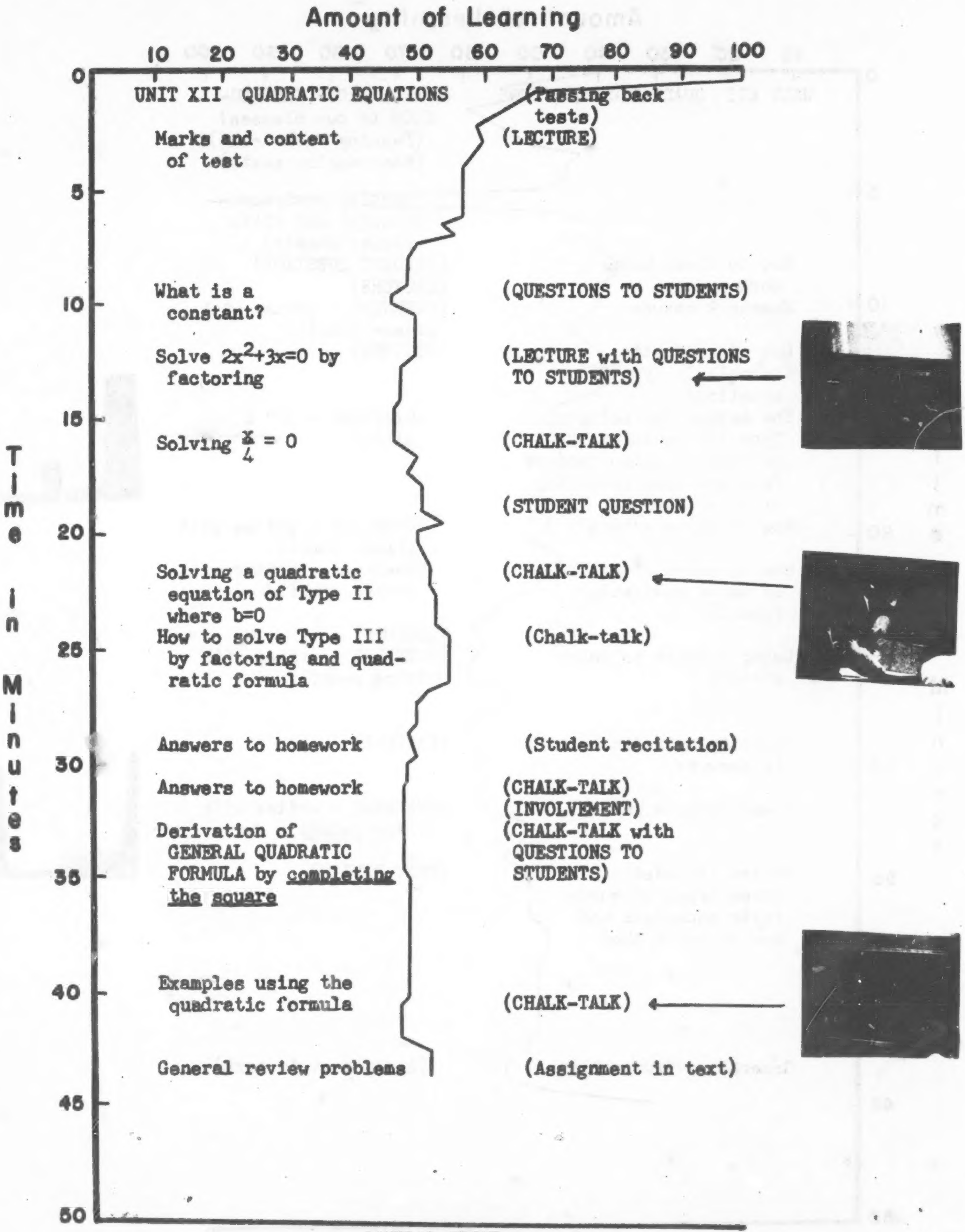
...

Solving quadratic equations by completing the square

(Assignment in text)

EXPERIMENTAL GROUP

LEARNING PROFILE NUMBER 278



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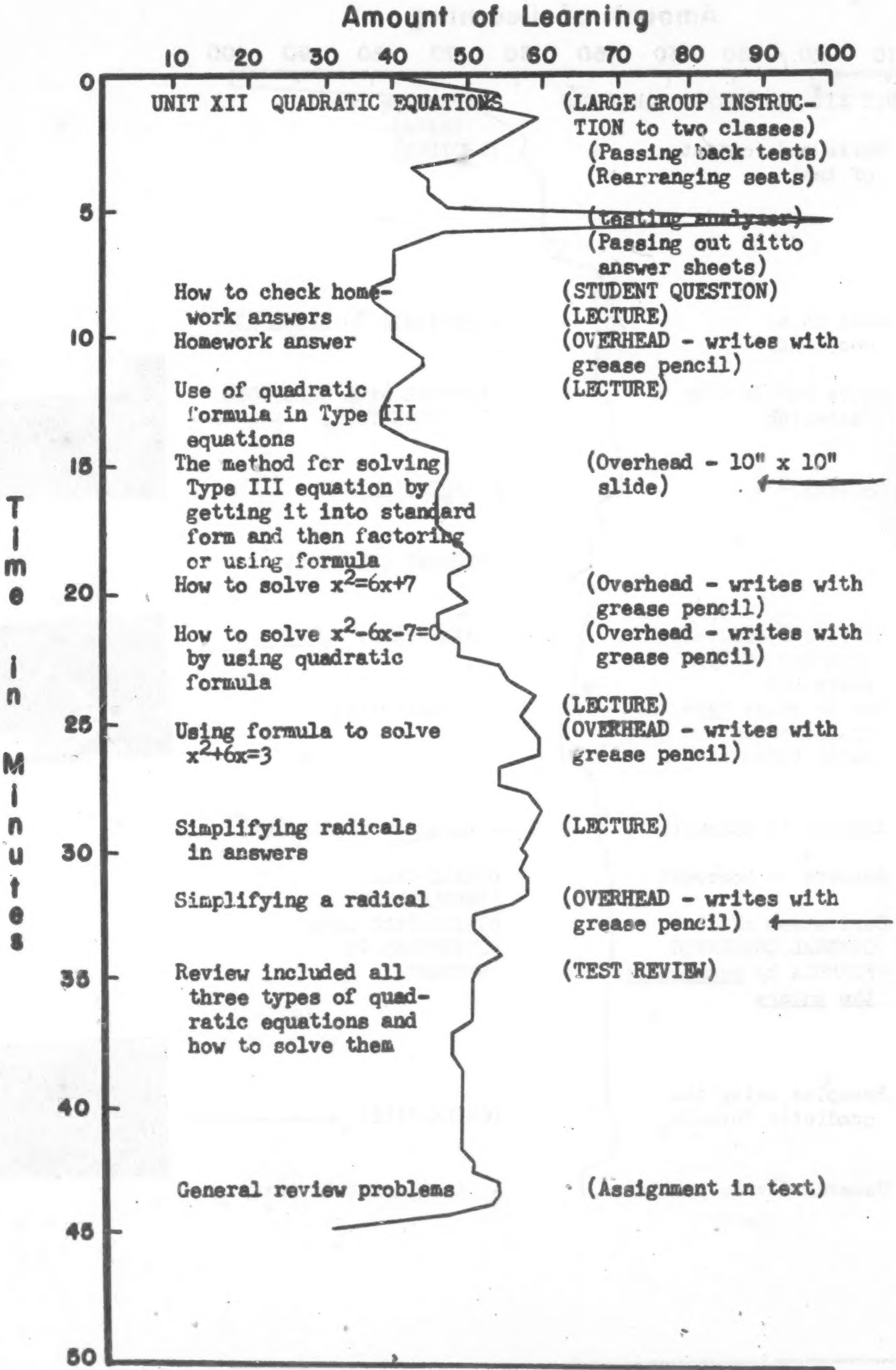

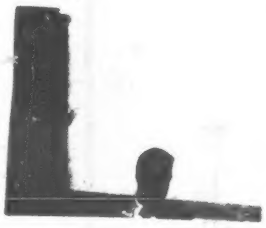

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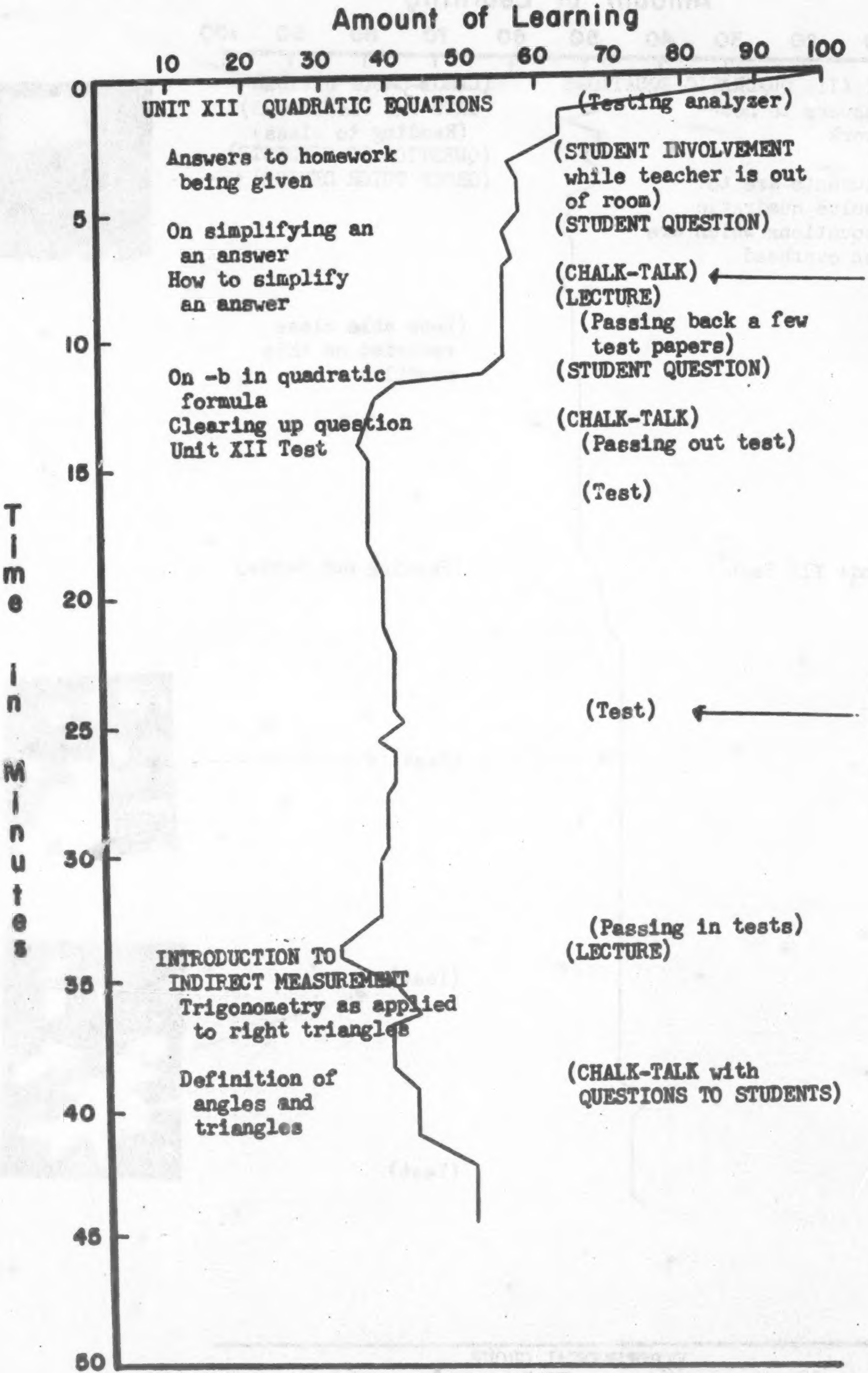

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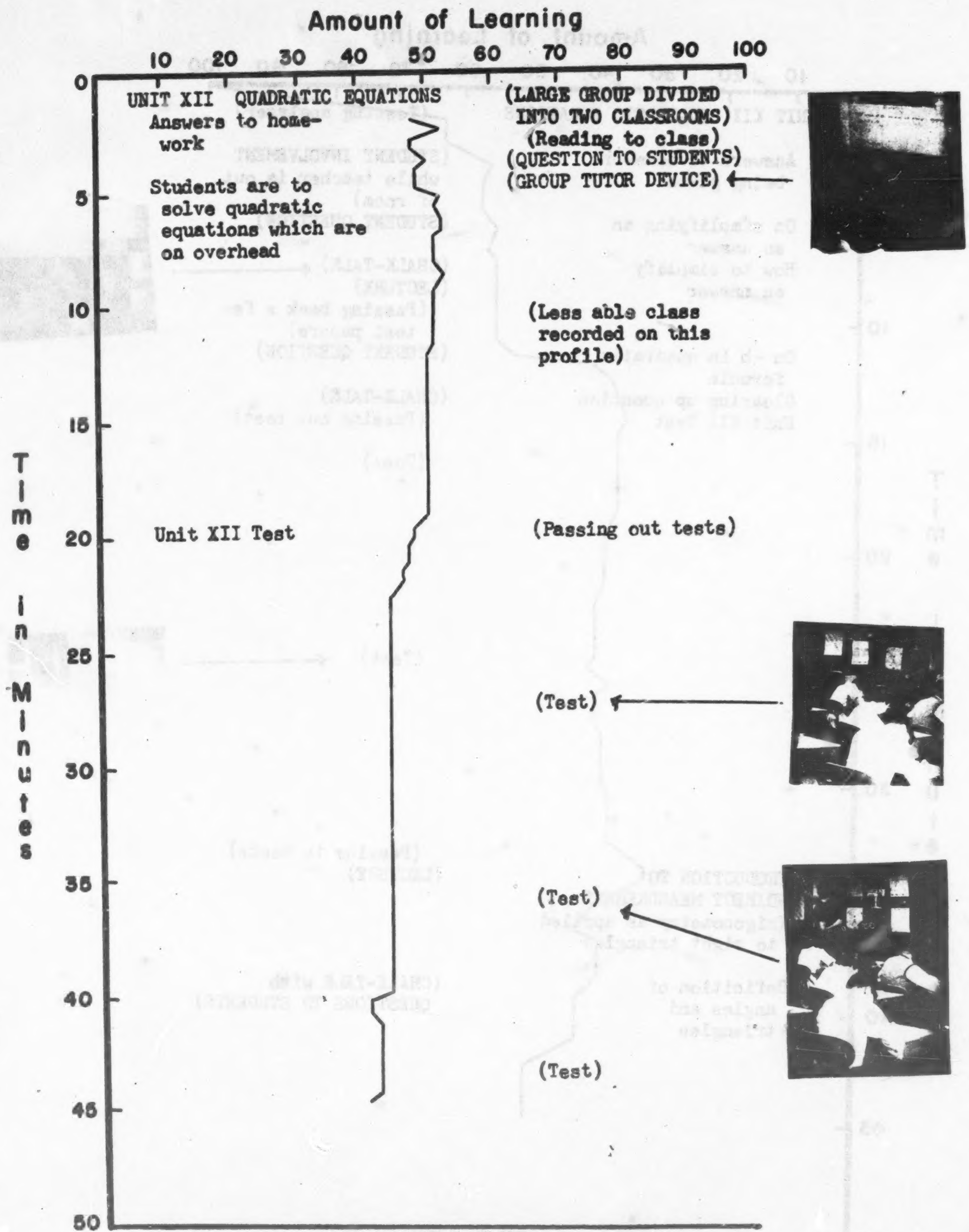

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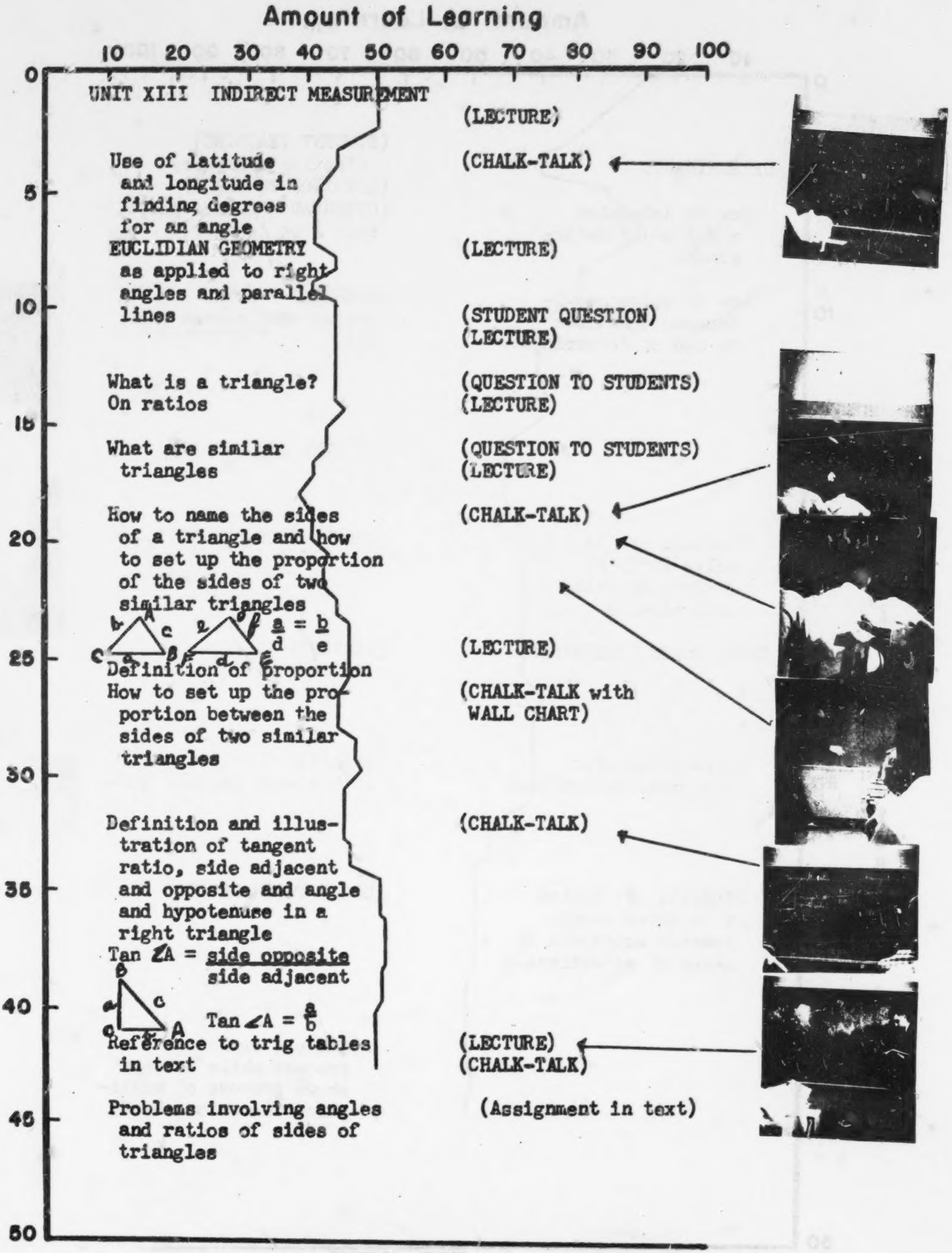

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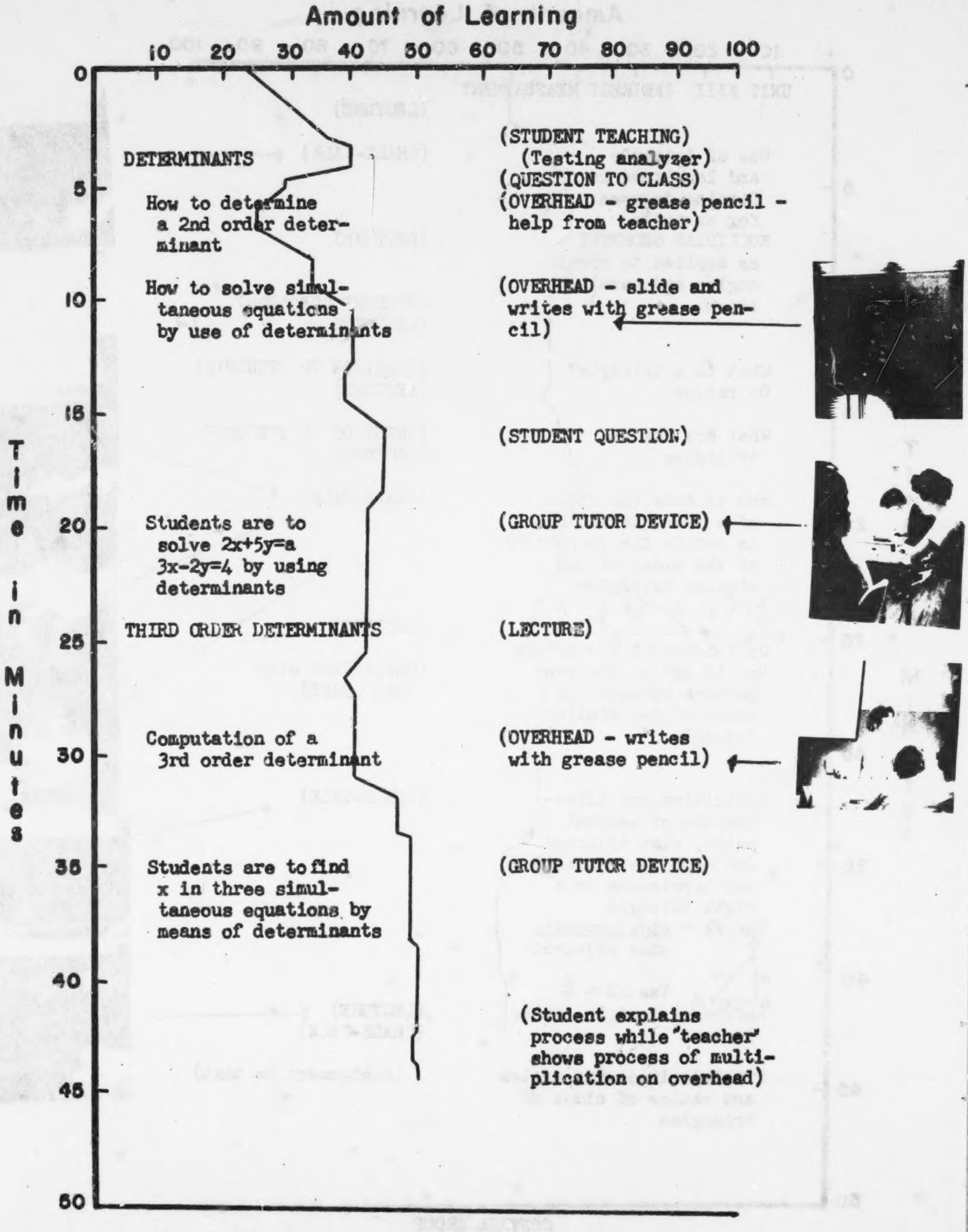

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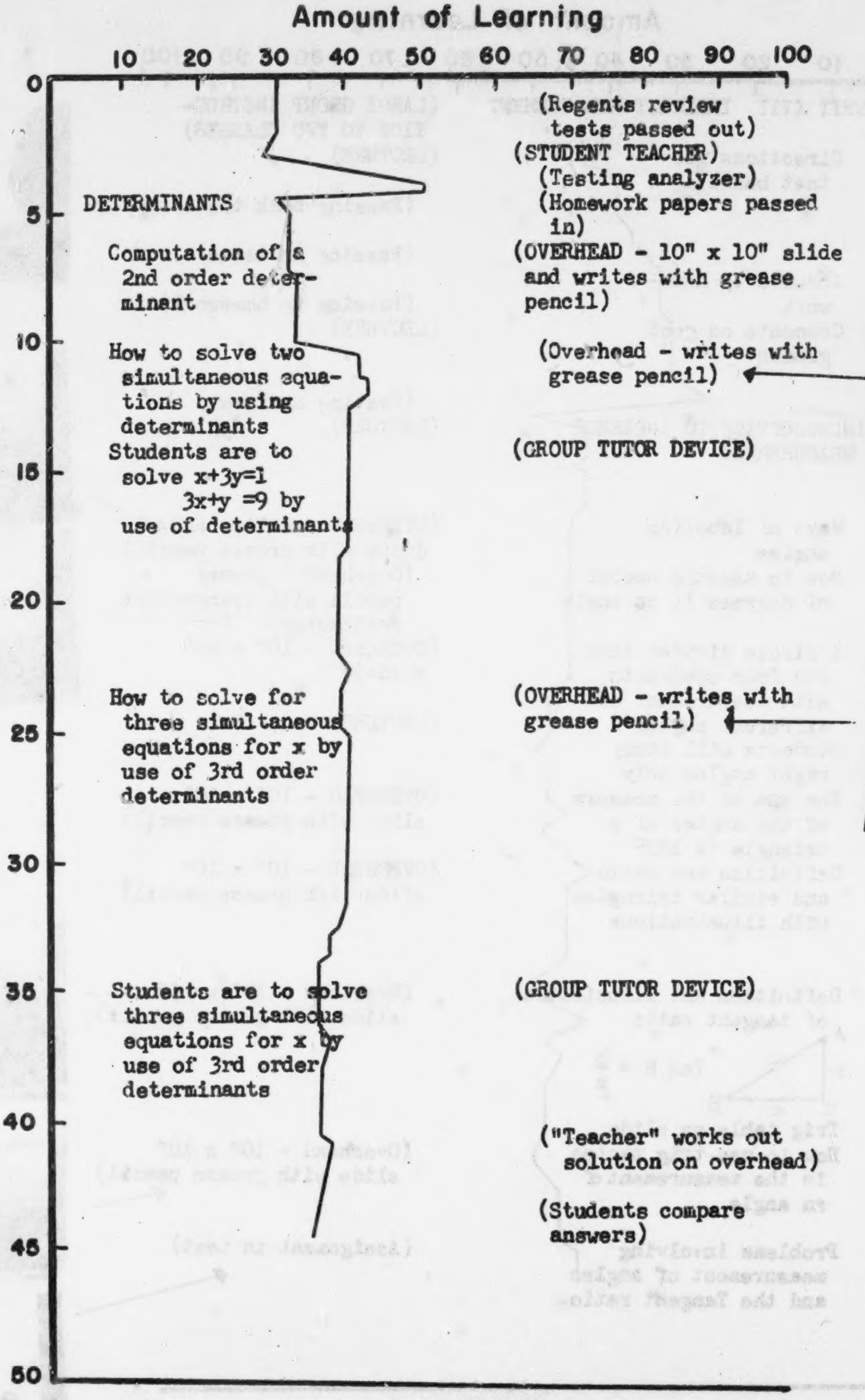

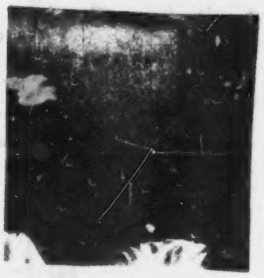

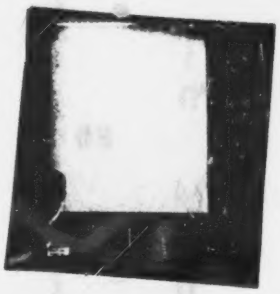

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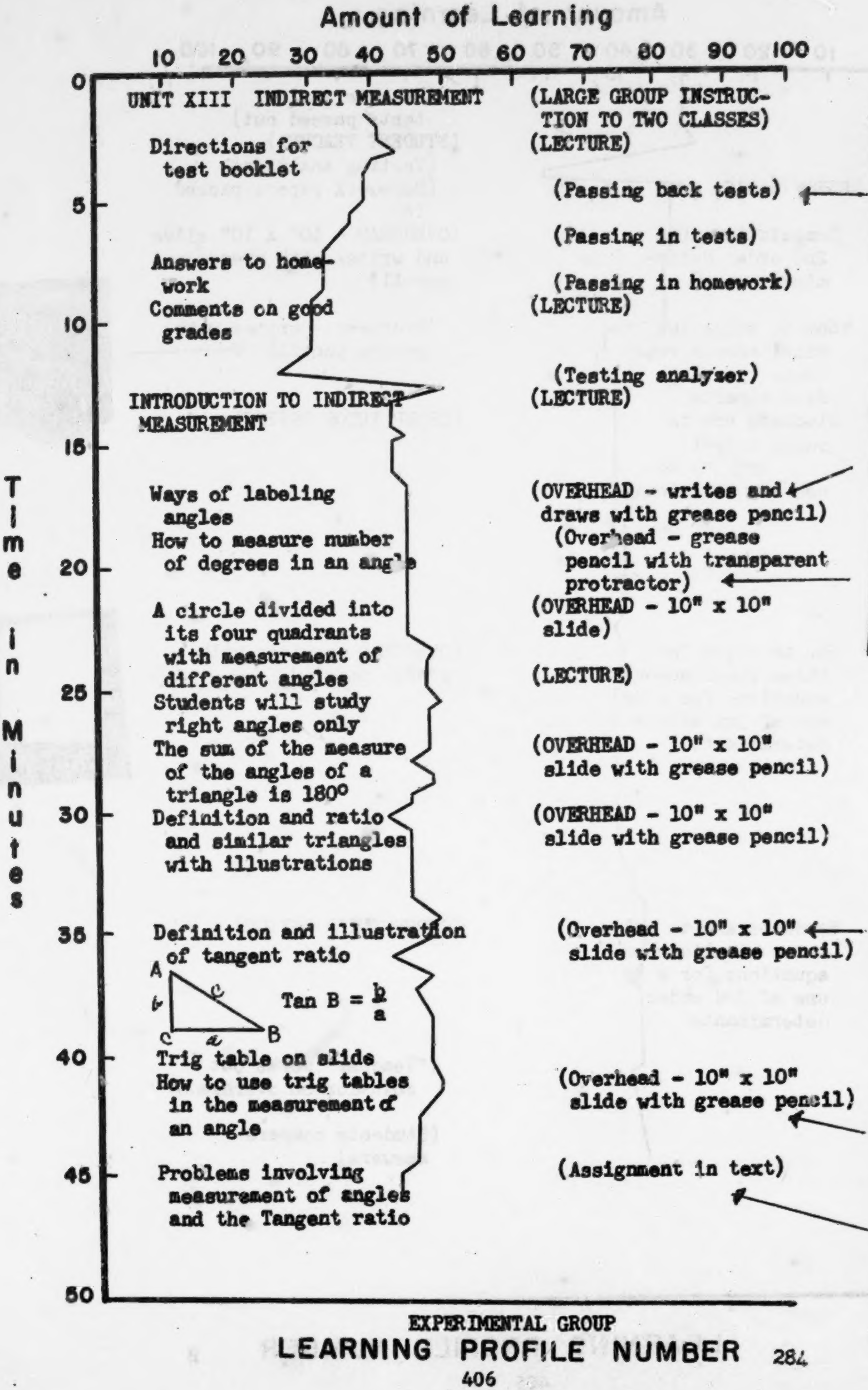

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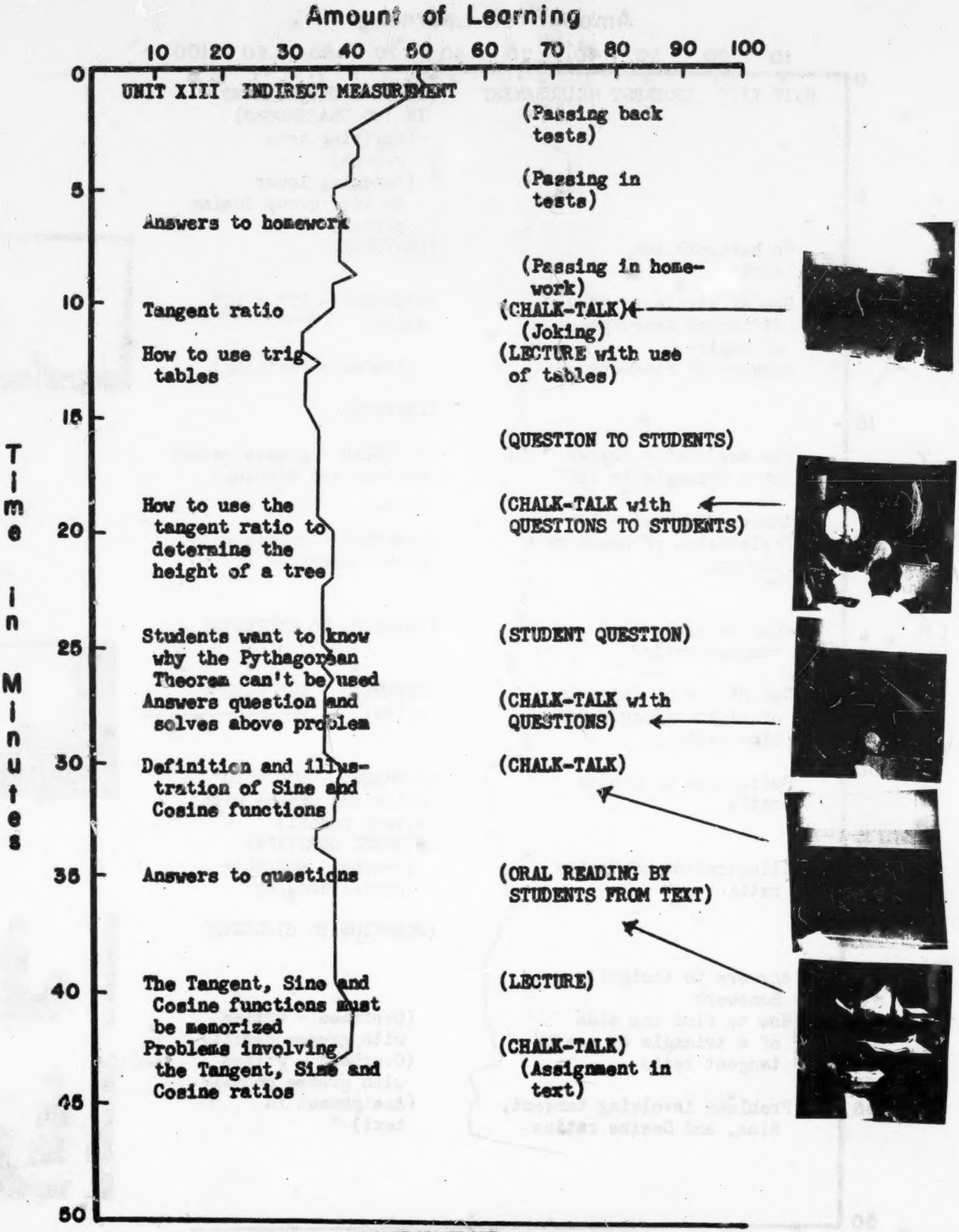

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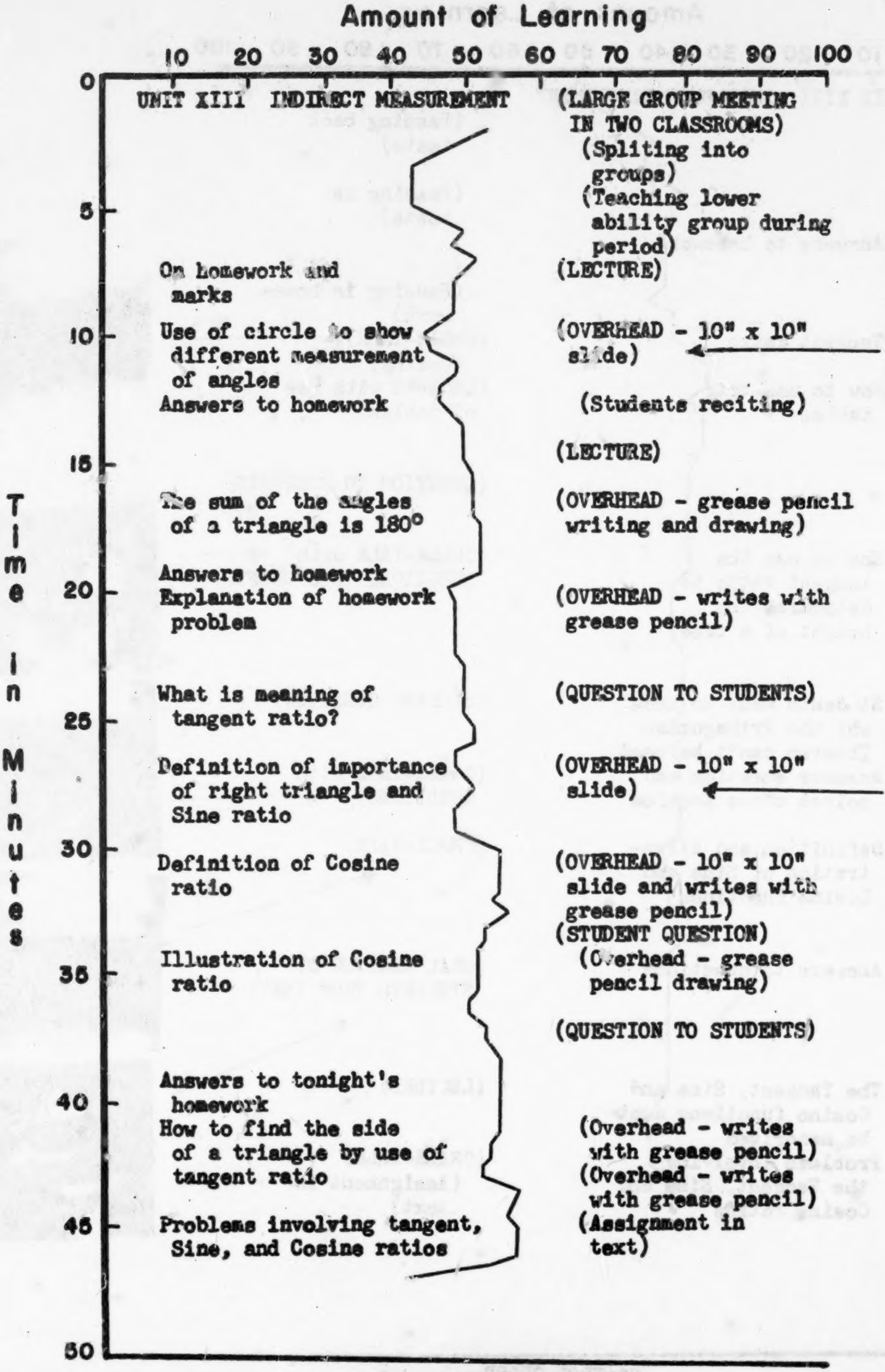

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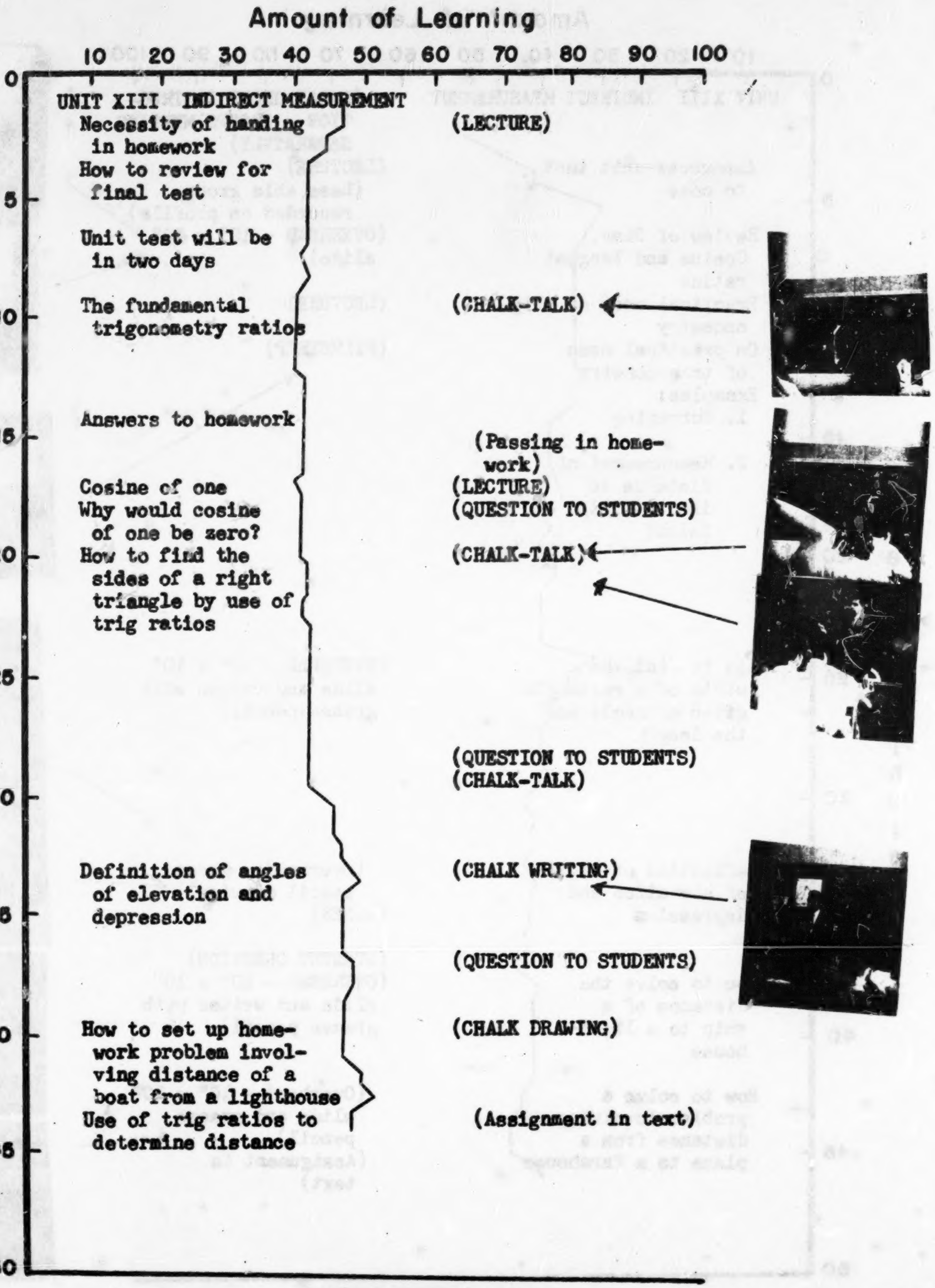

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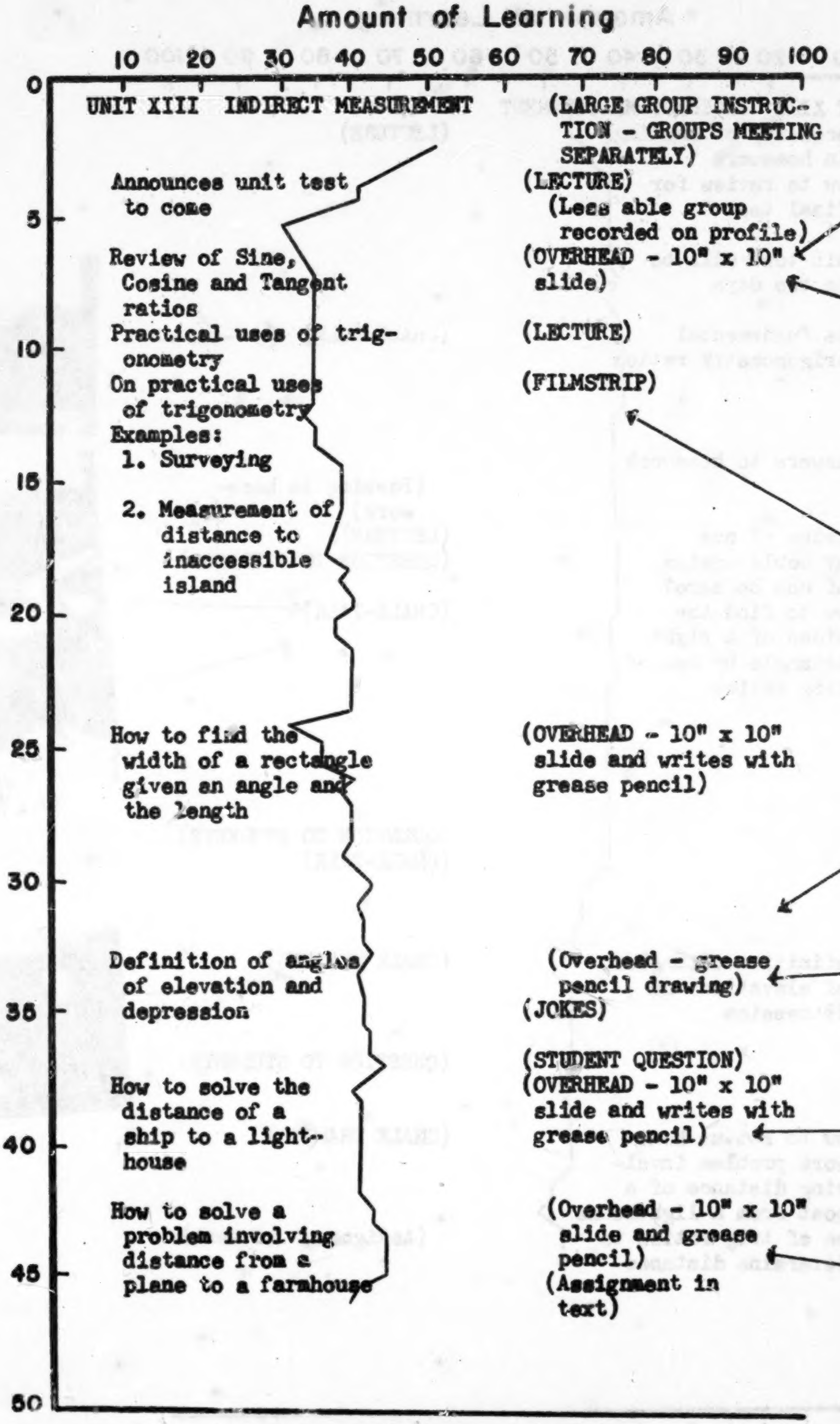

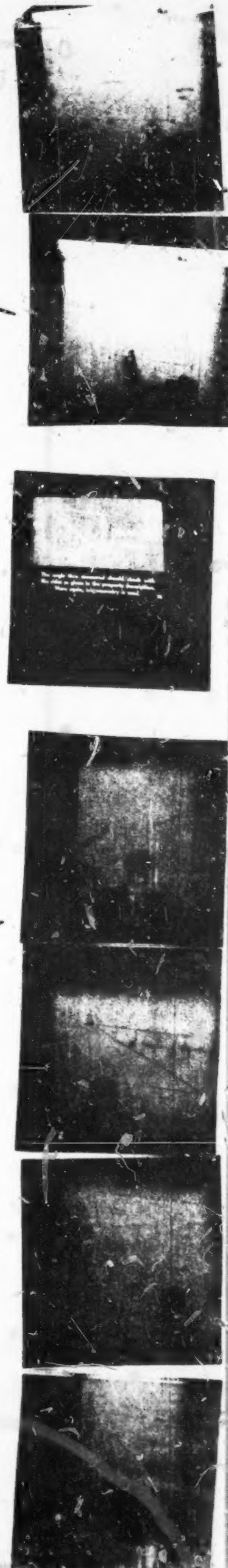

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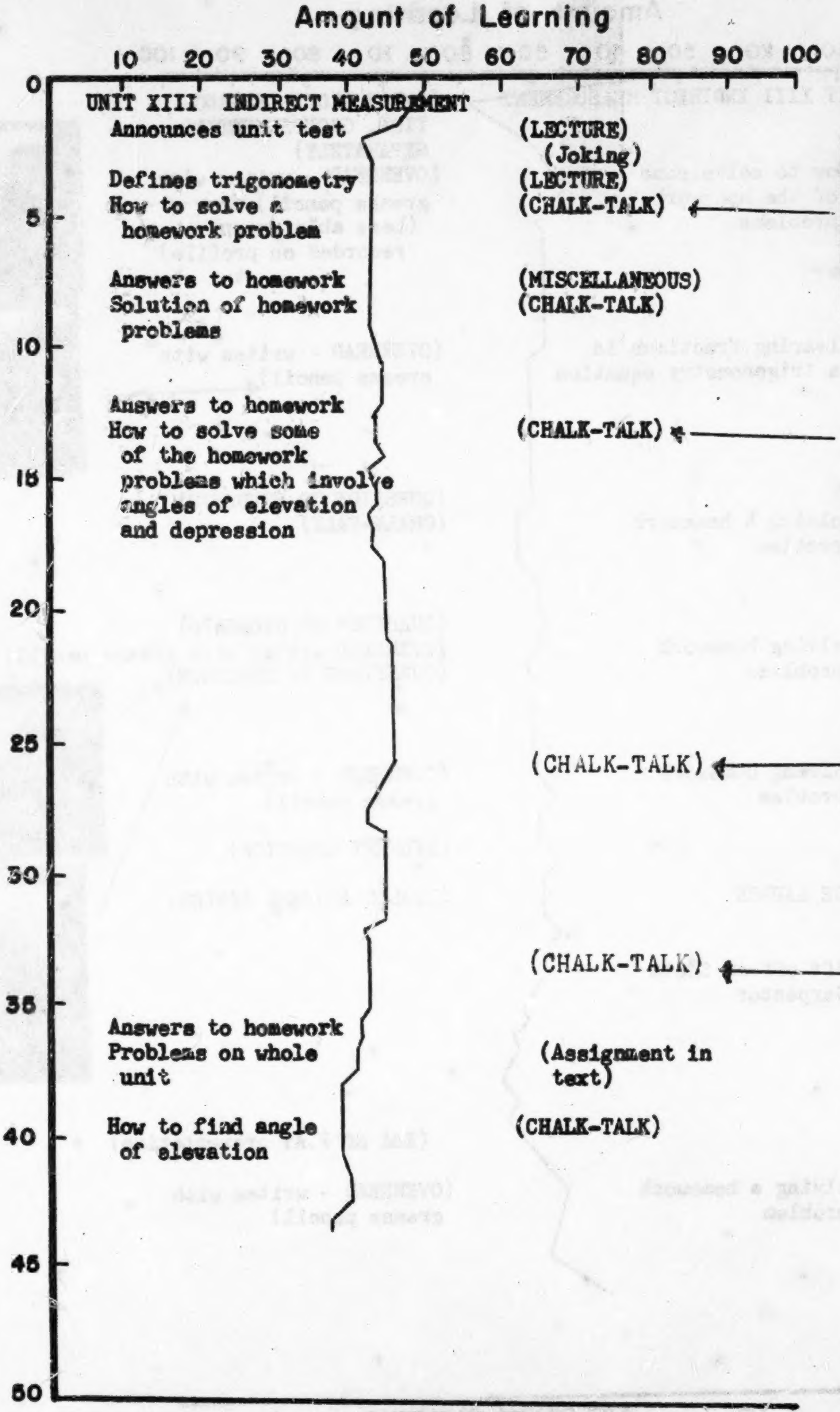

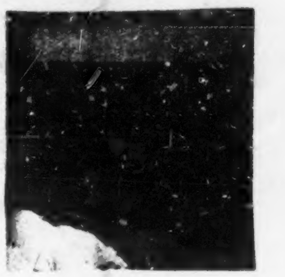

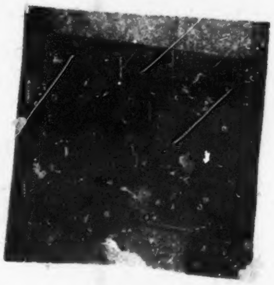

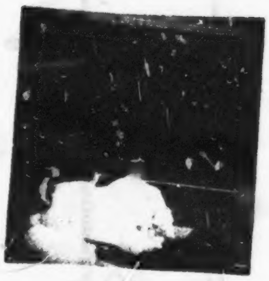

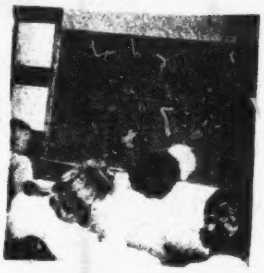

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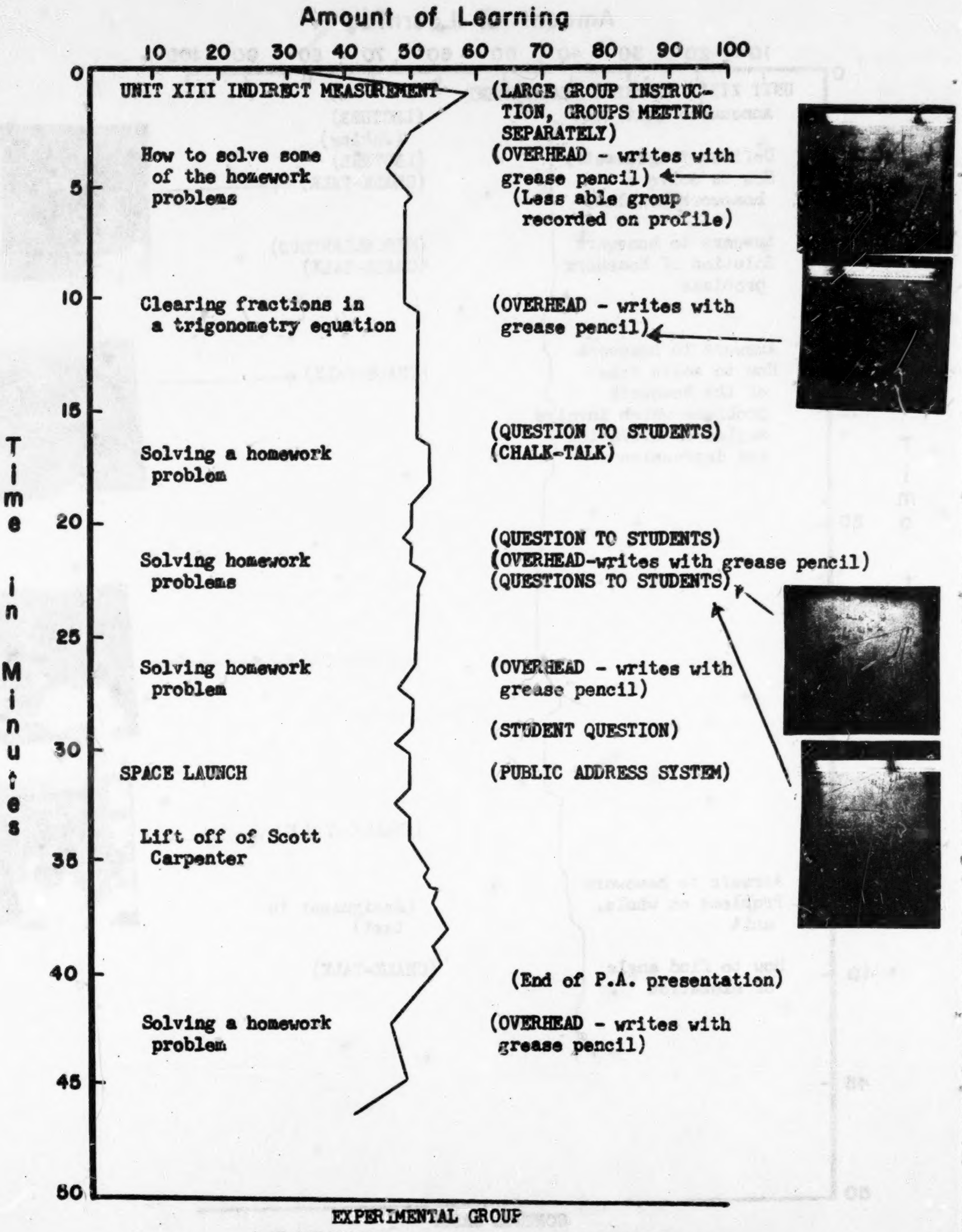

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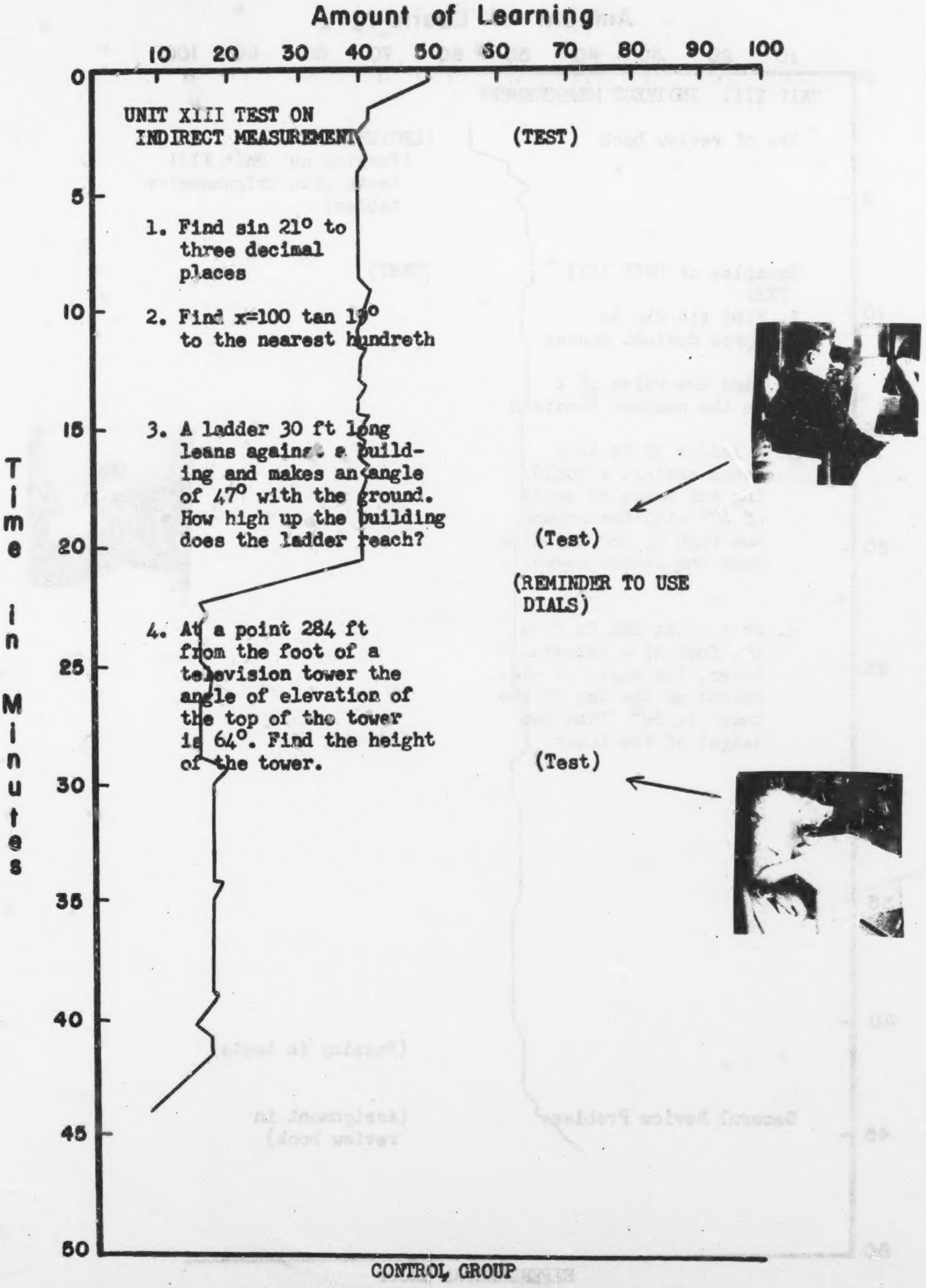

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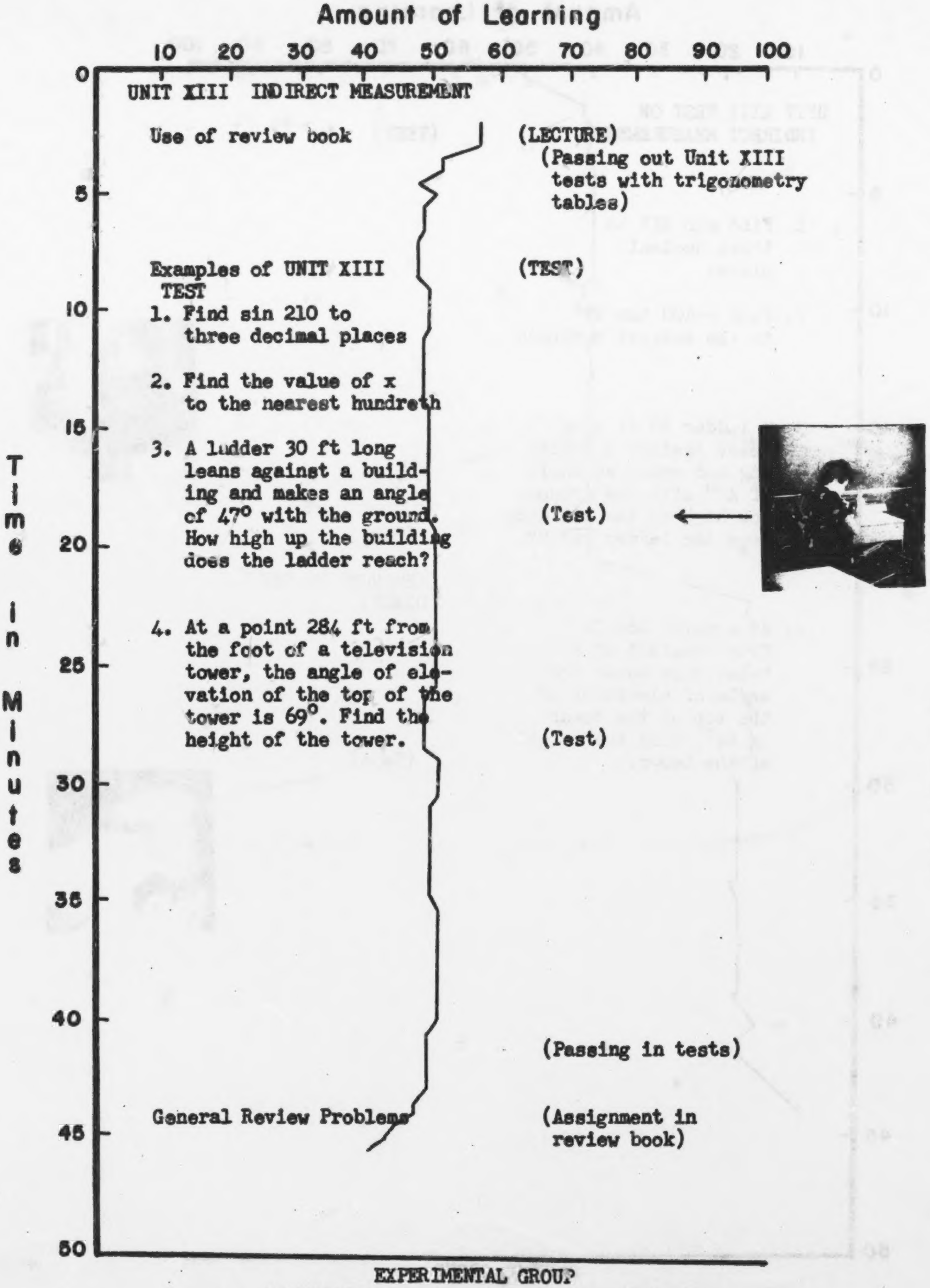

UNIT XIII INDIRECT MEASUREMENT

Use of review book

(LECTURE)

(Passing out Unit XIII tests with trigonometry tables)

Examples of UNIT XIII TEST

(TEST)

1. Find sin 210 to three decimal places
2. Find the value of x to the nearest hundreth
3. A ladder 30 ft long leans against a building and makes an angle of 47° with the ground. How high up the building does the ladder reach?
4. At a point 284 ft from the foot of a television tower, the angle of elevation of the top of the tower is 69°. Find the height of the tower.

(Test)

(Test)

(Passing in tests)

General Review Problems

(Assignment in review book)

EXPERIMENTAL GROUP

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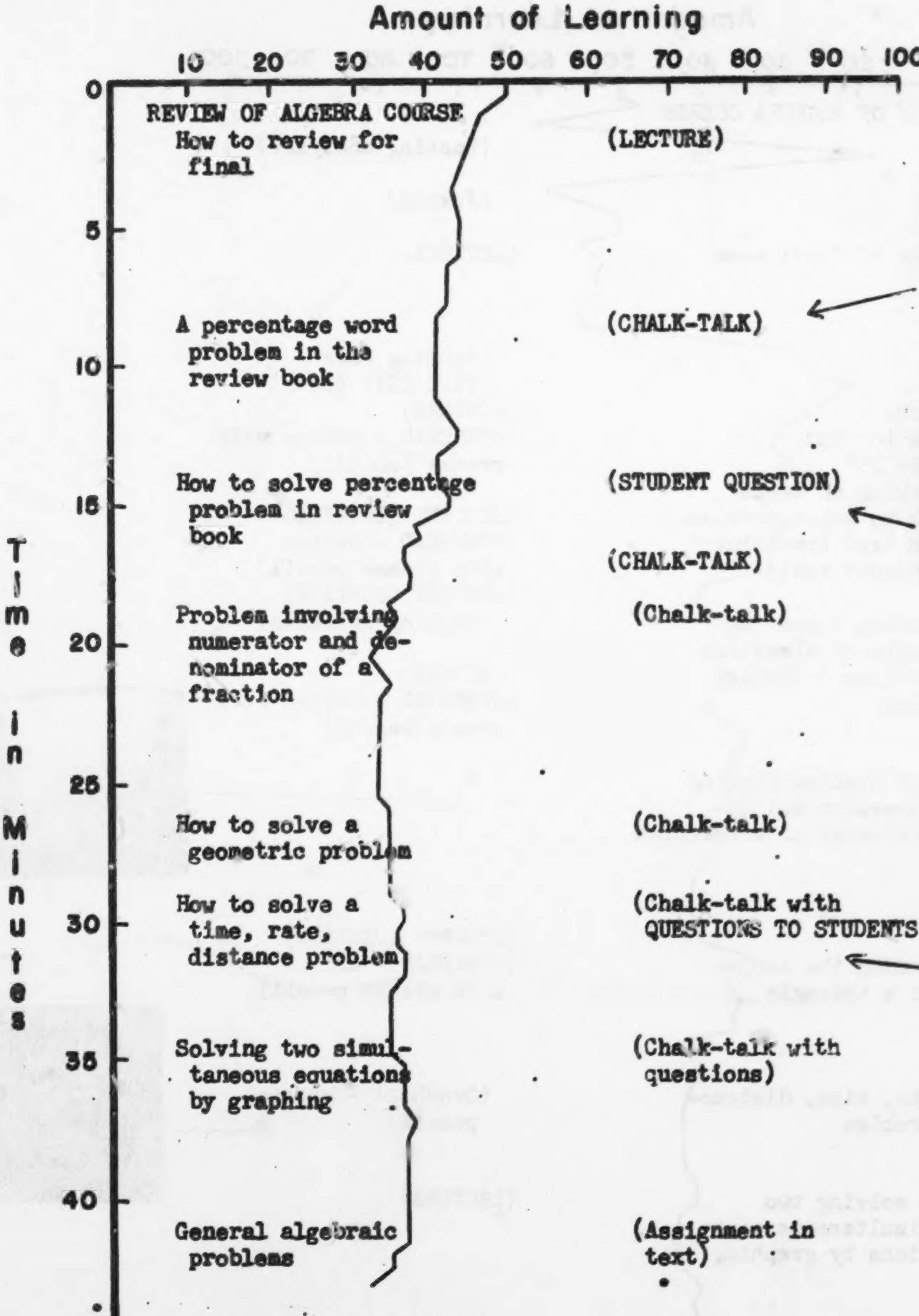

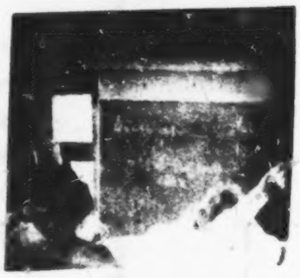

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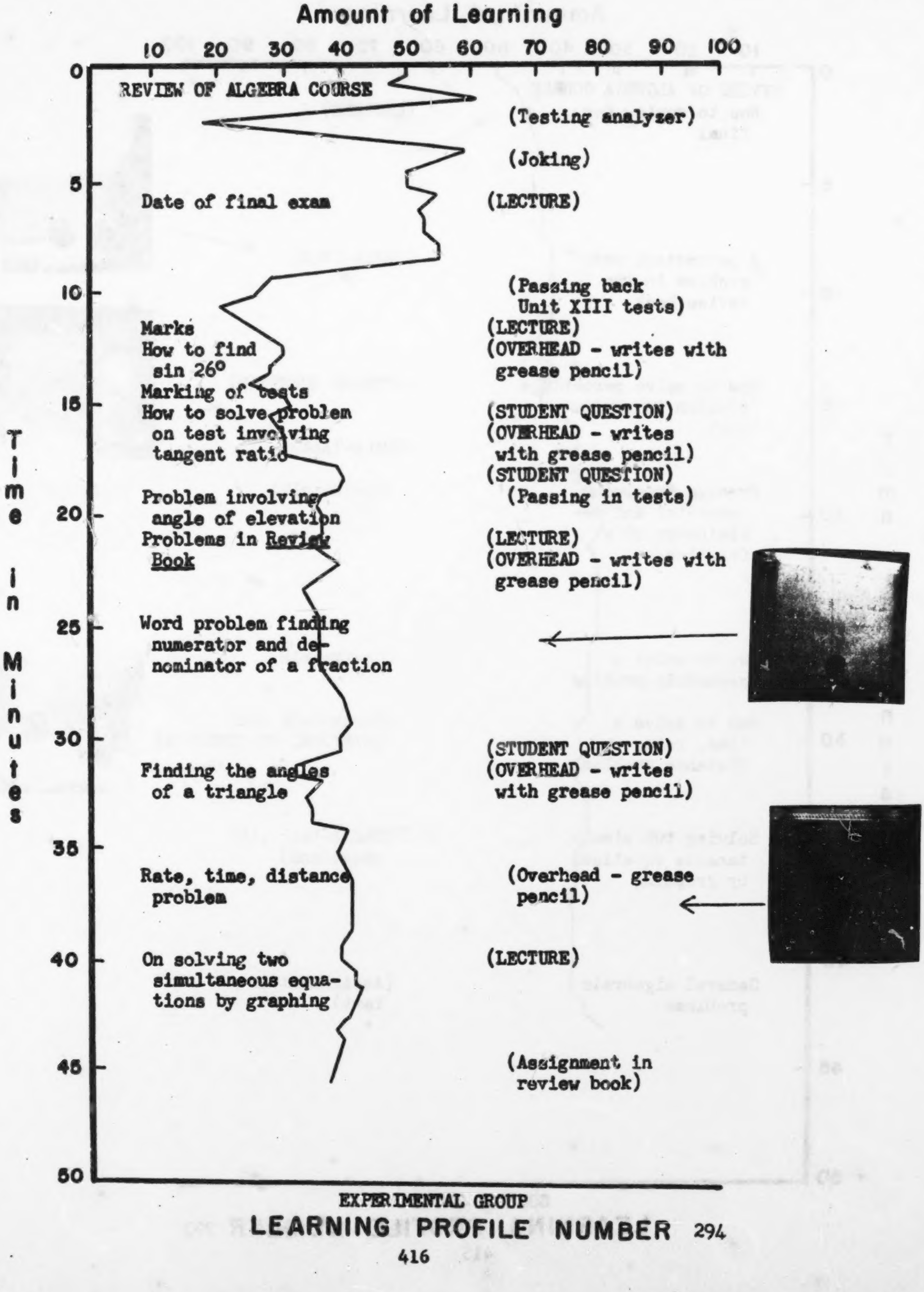

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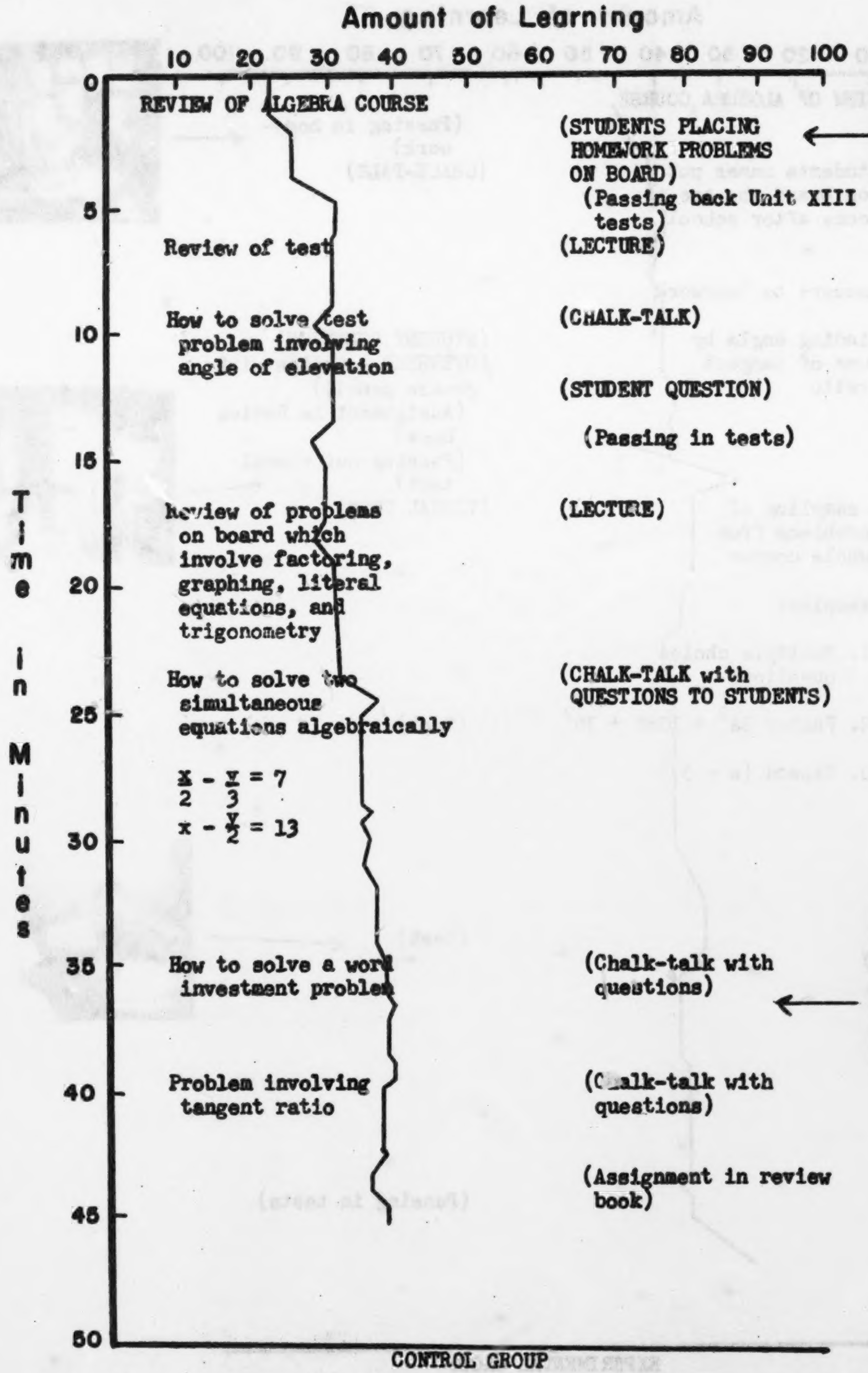

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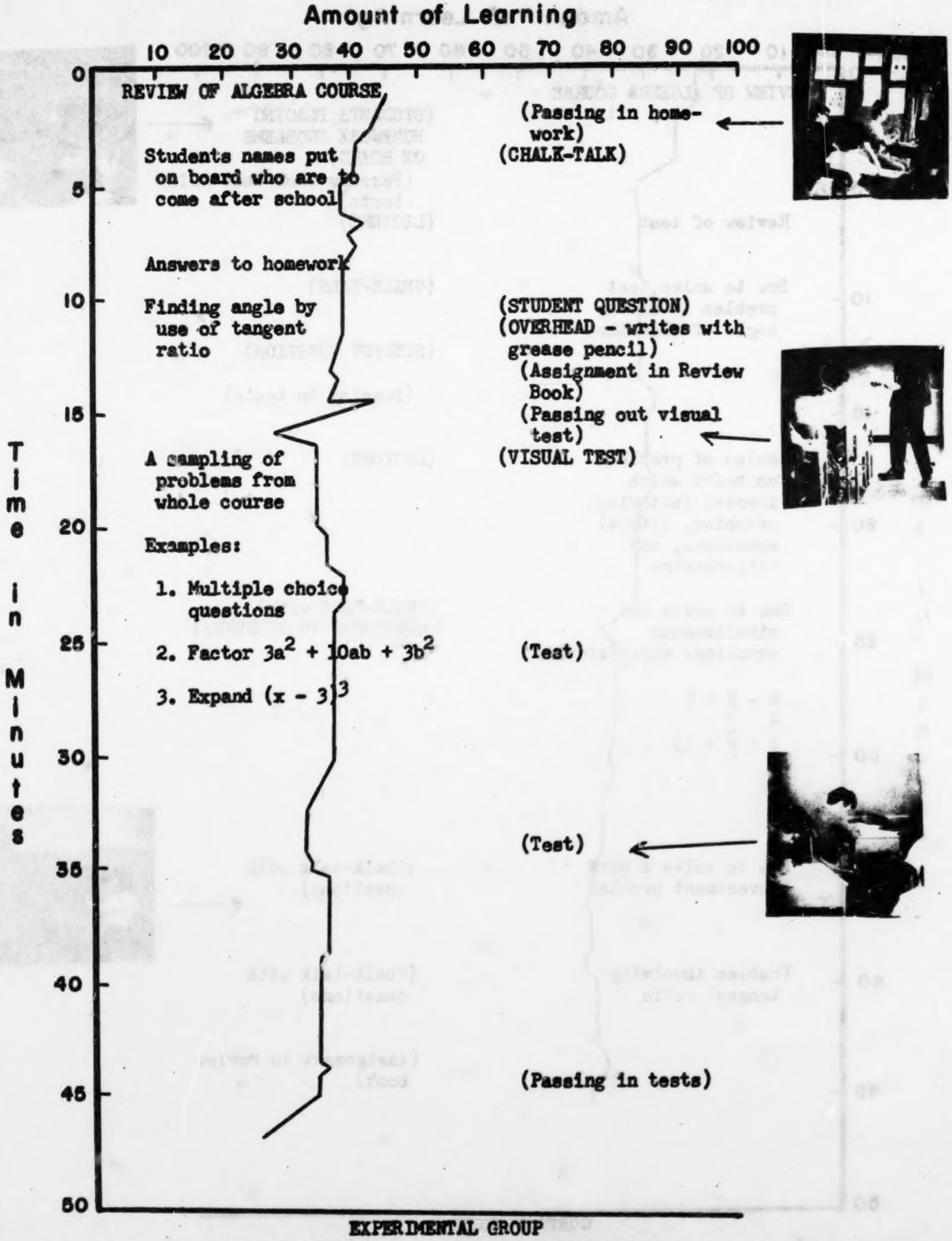

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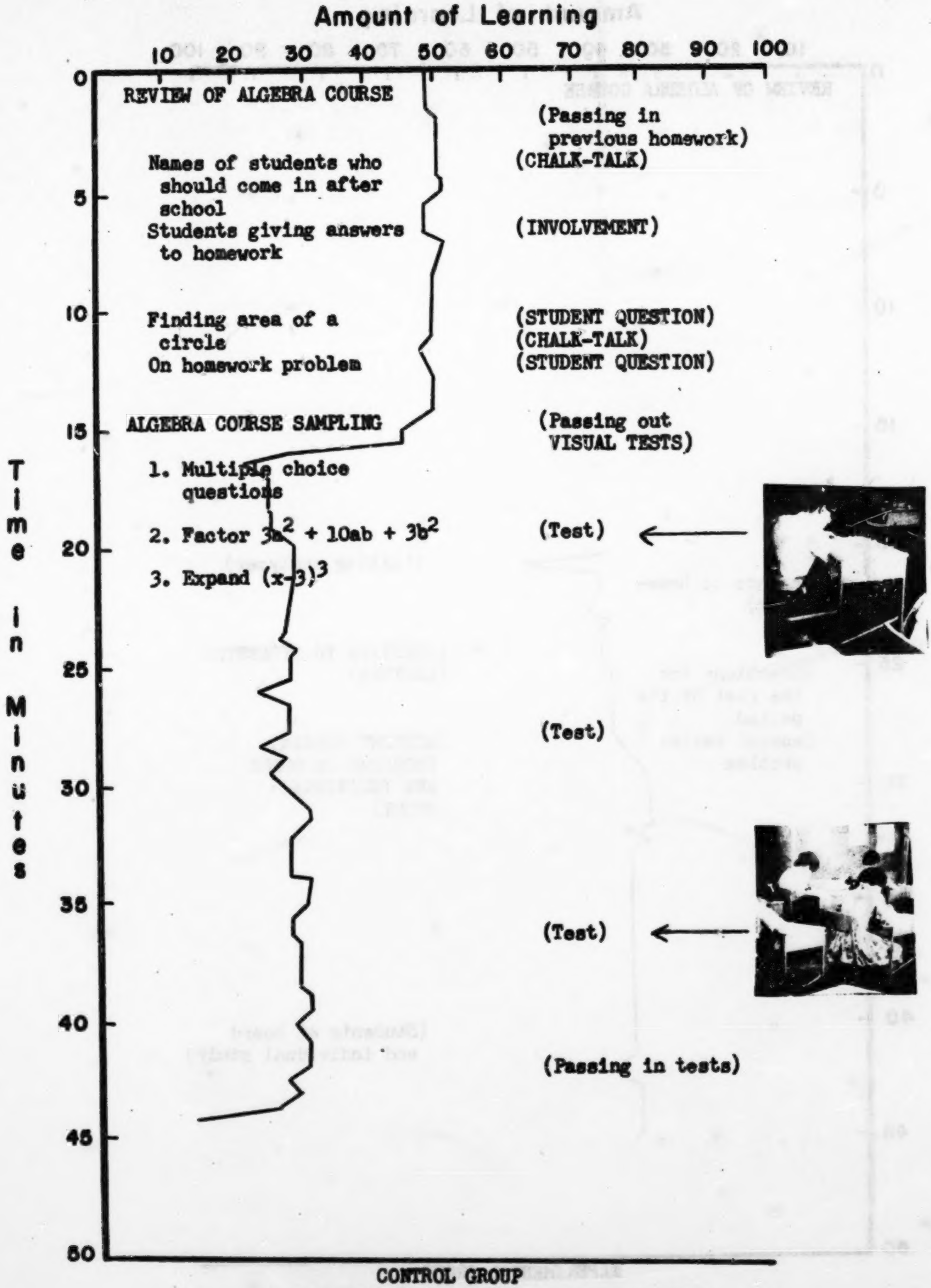

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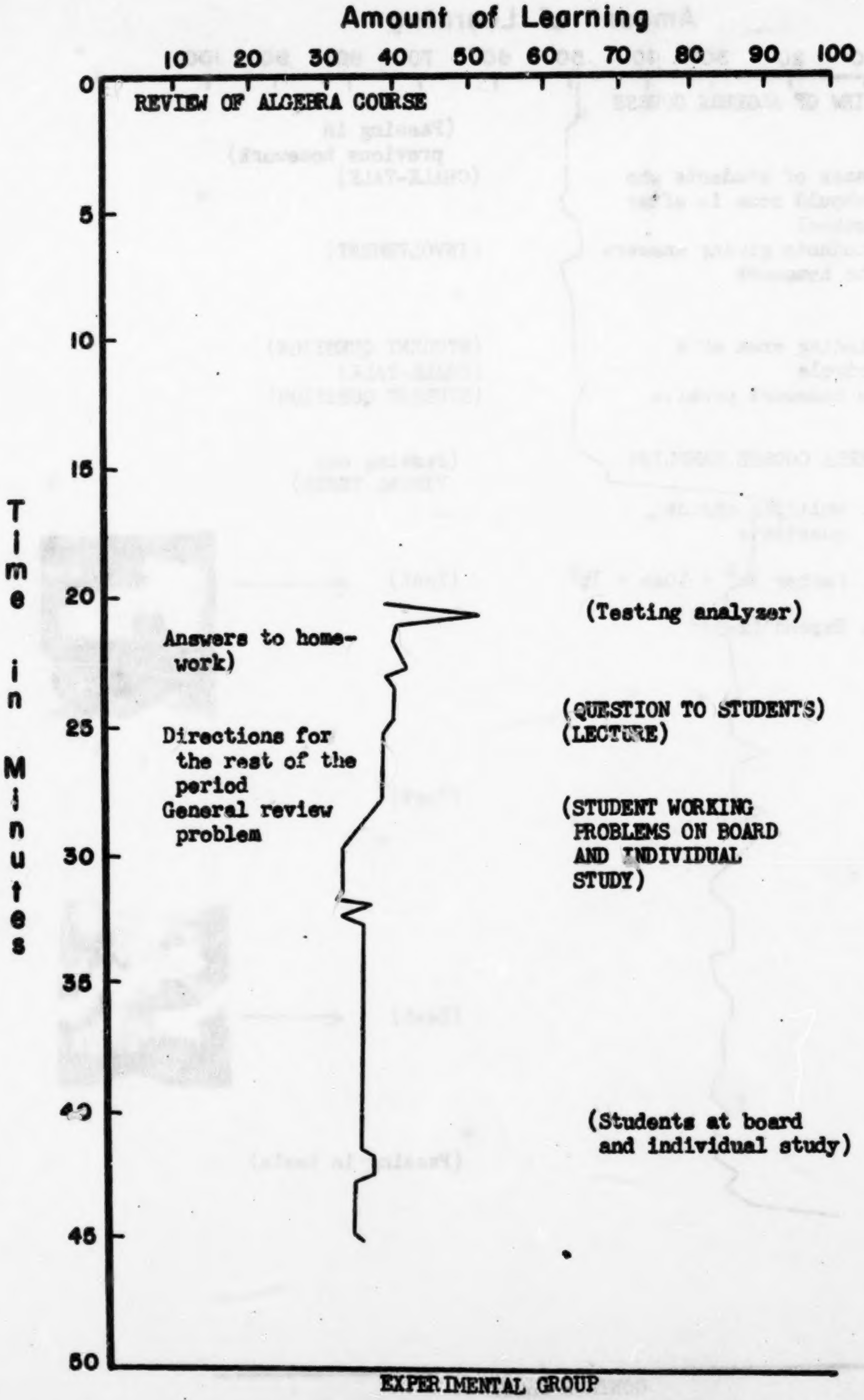

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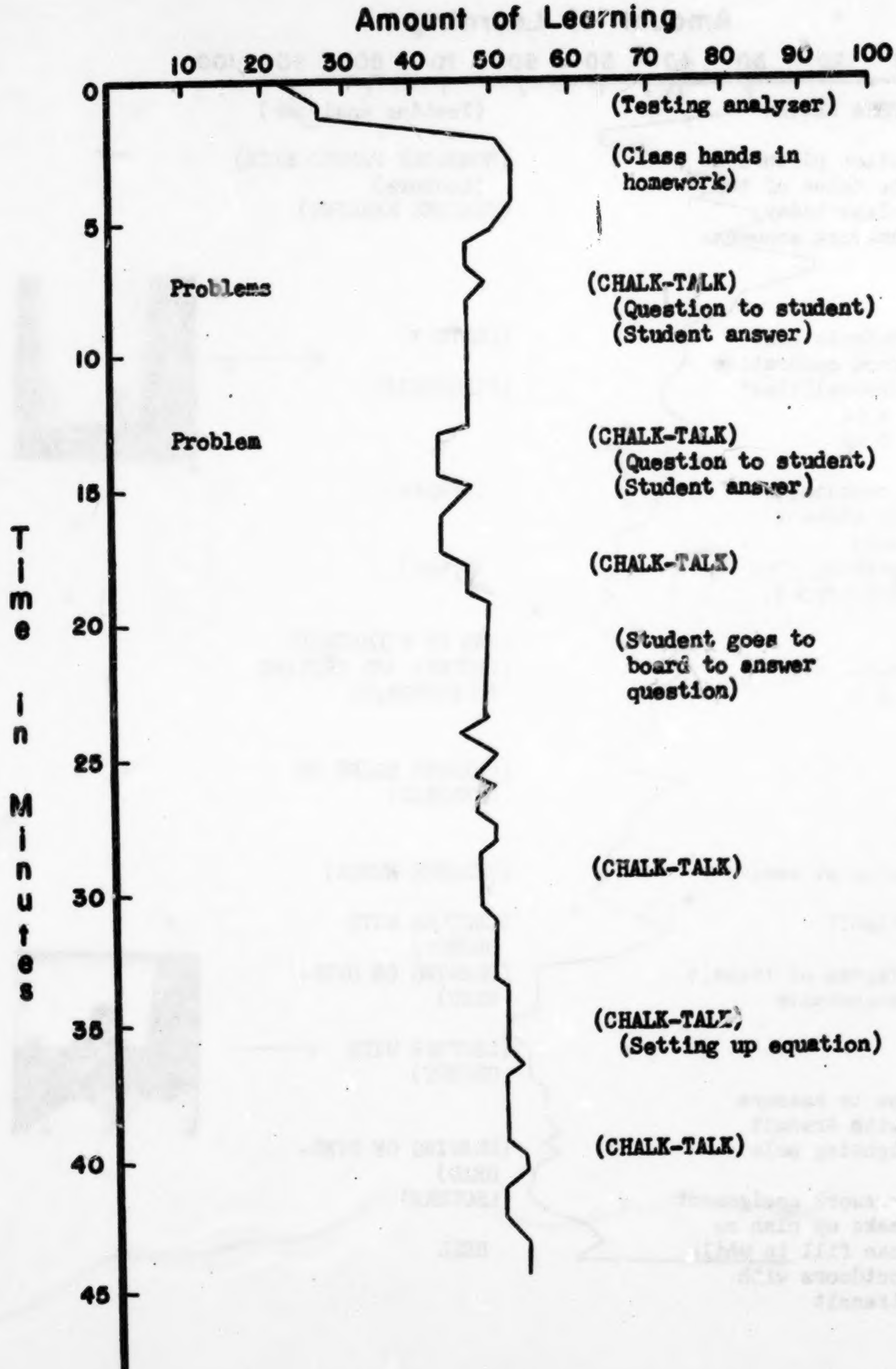

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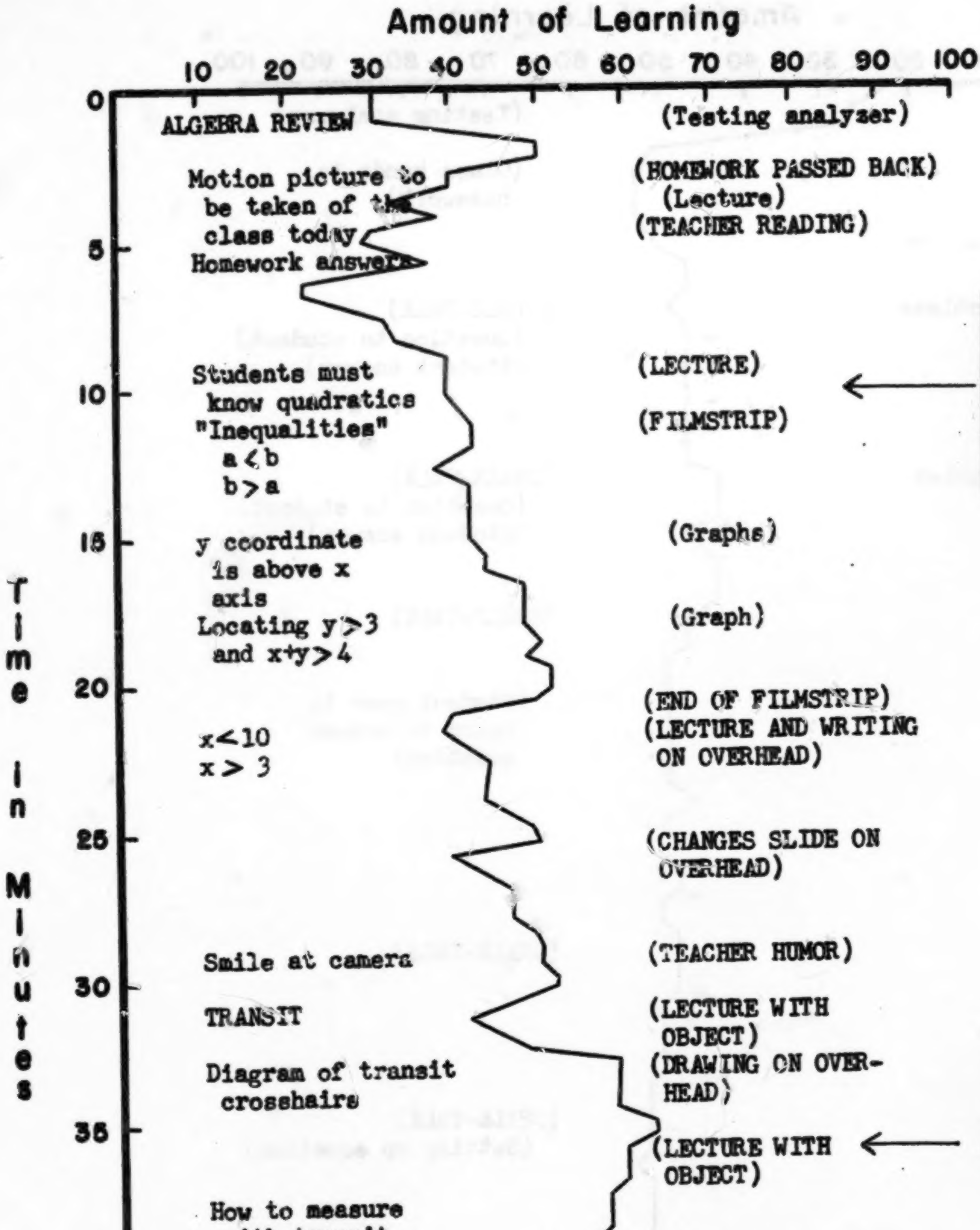

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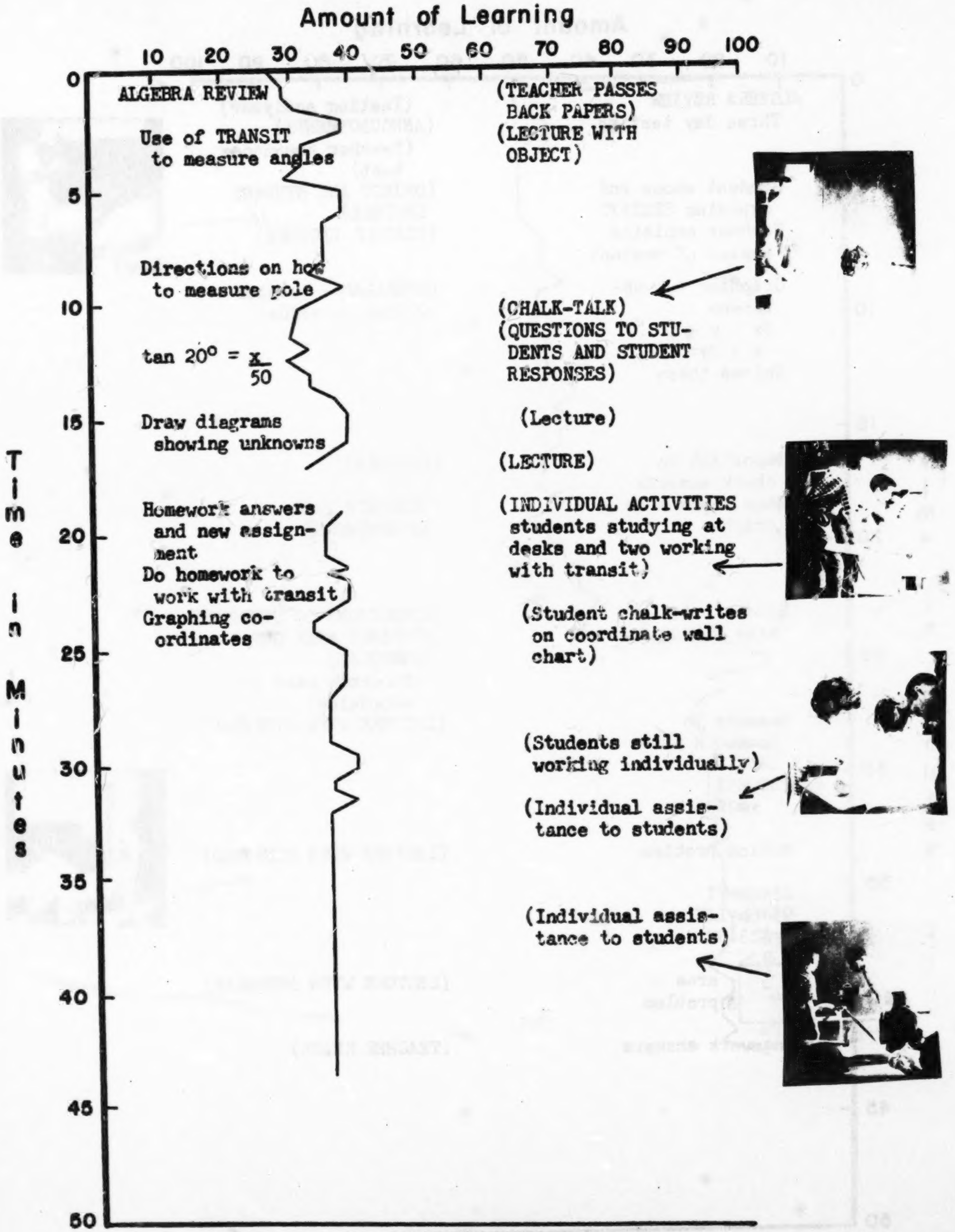

CONTROL GROUP

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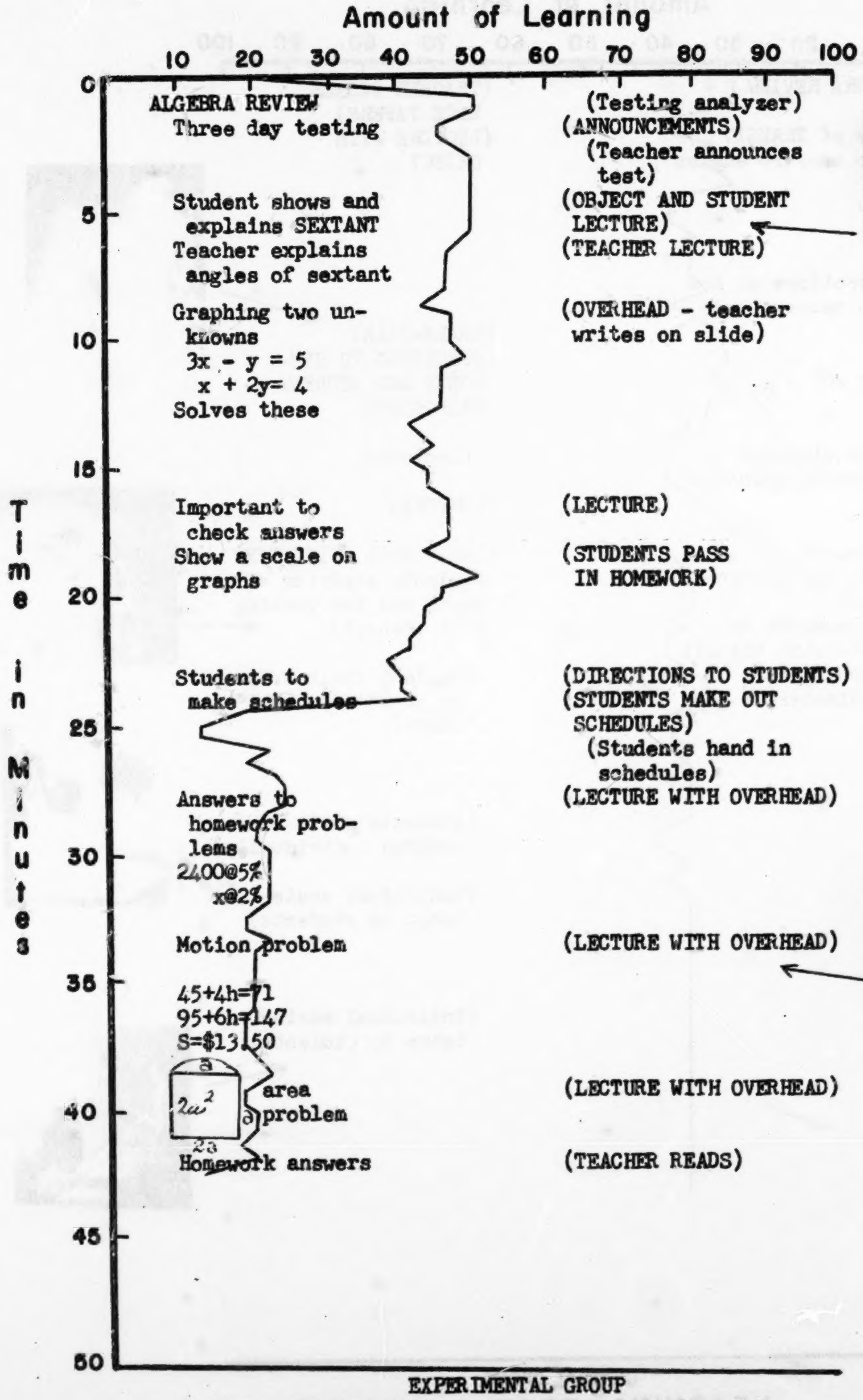

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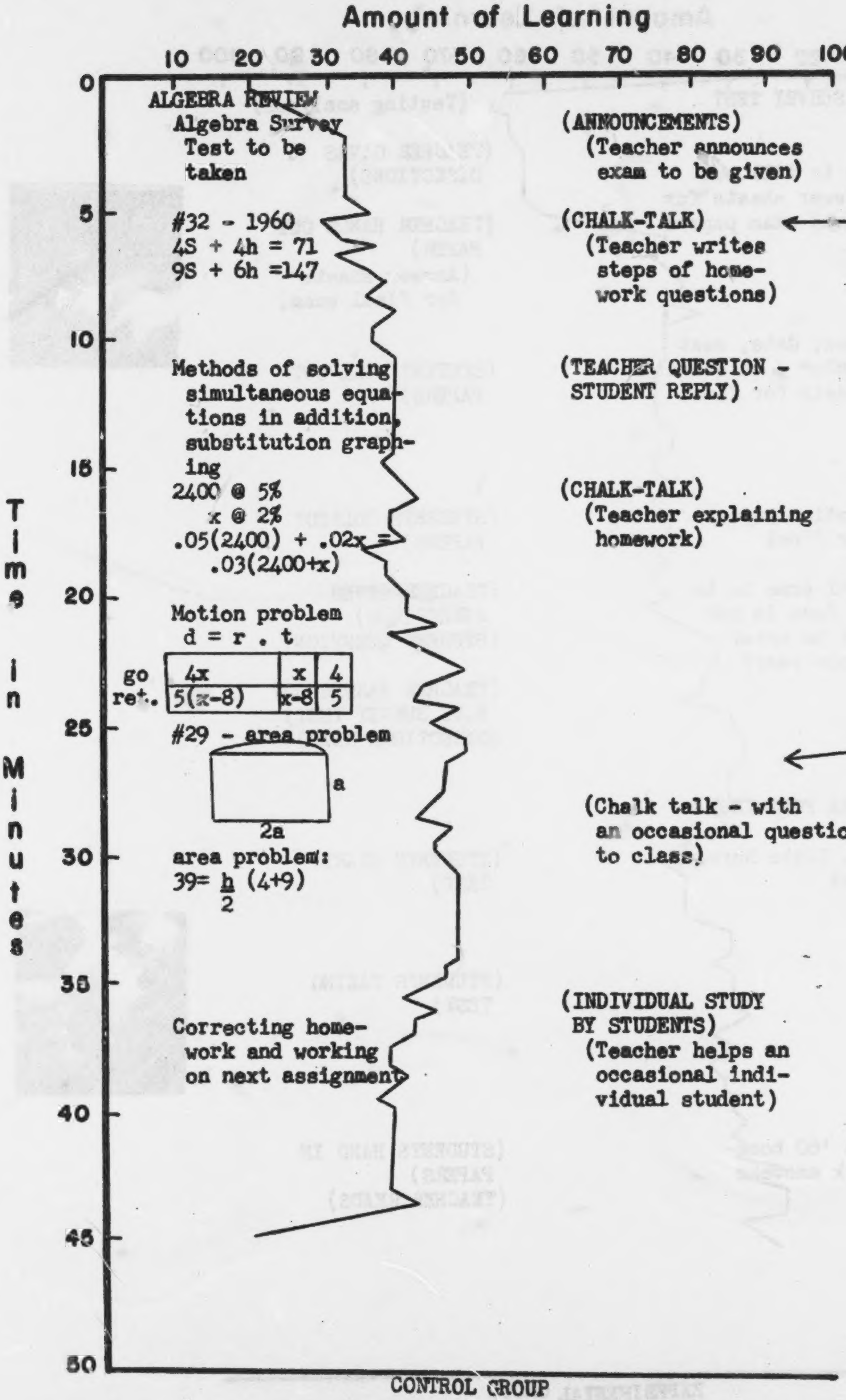

CONTROL GROUP

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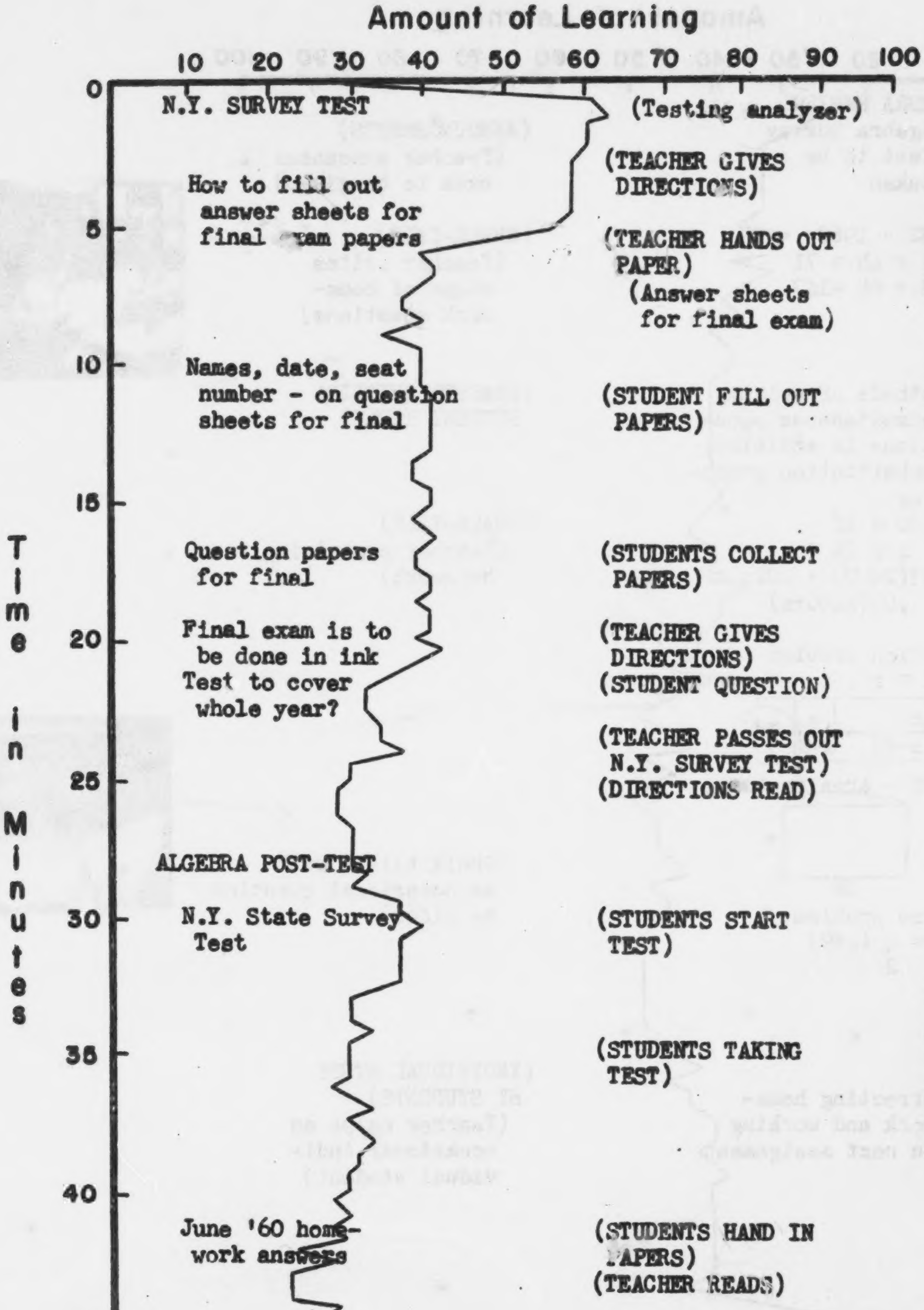

EXPERIMENTAL GROUP

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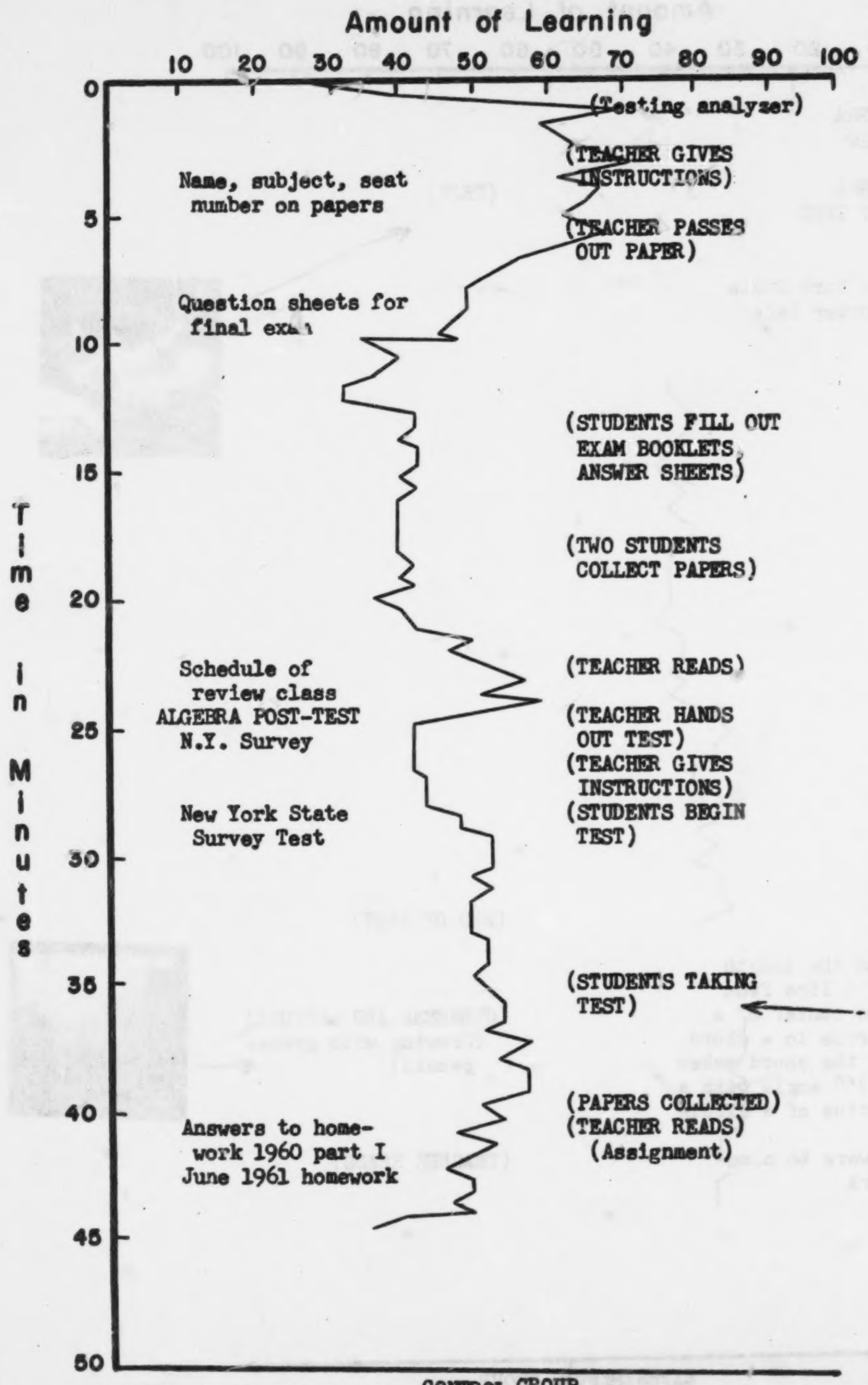

CONTROL GROUP

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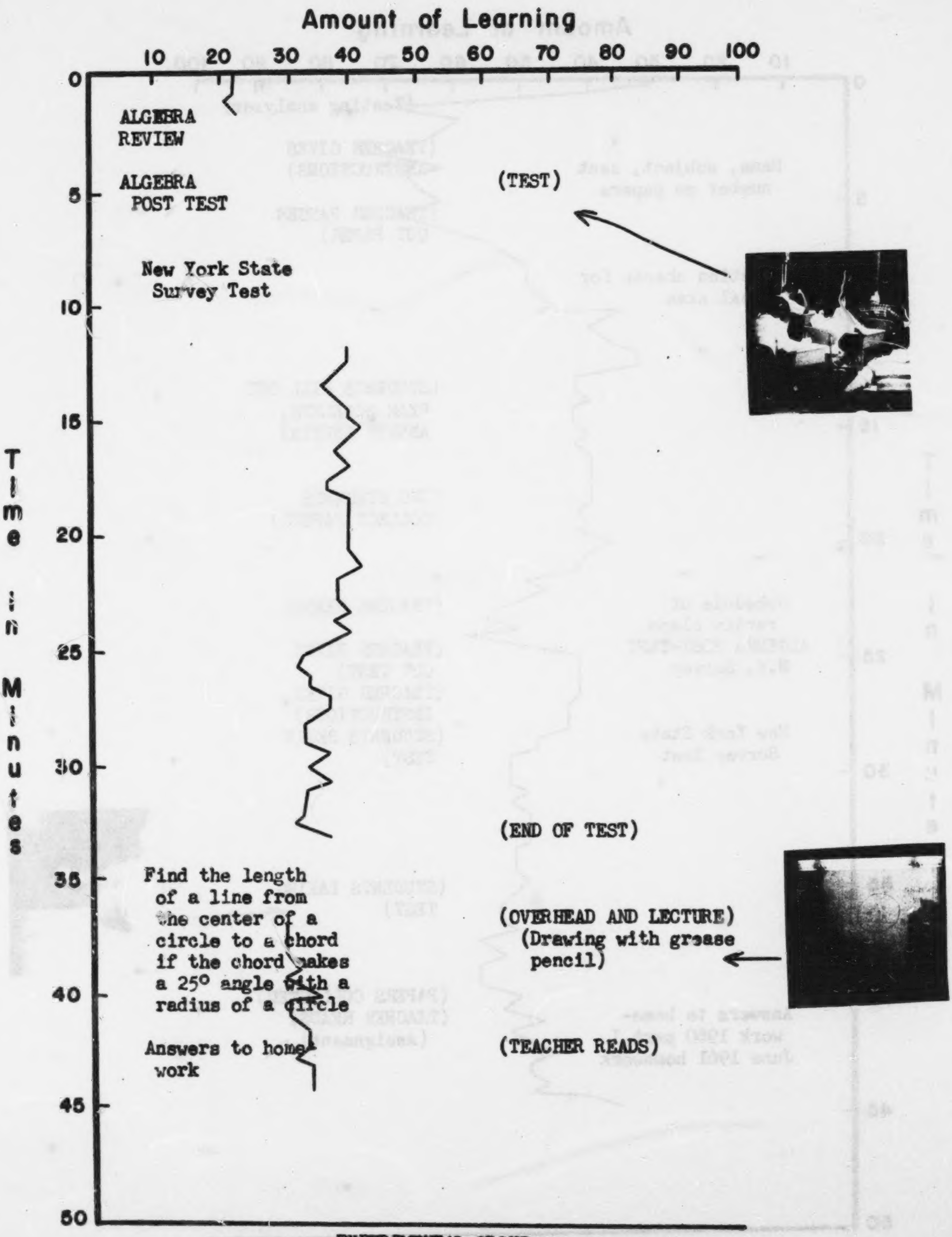

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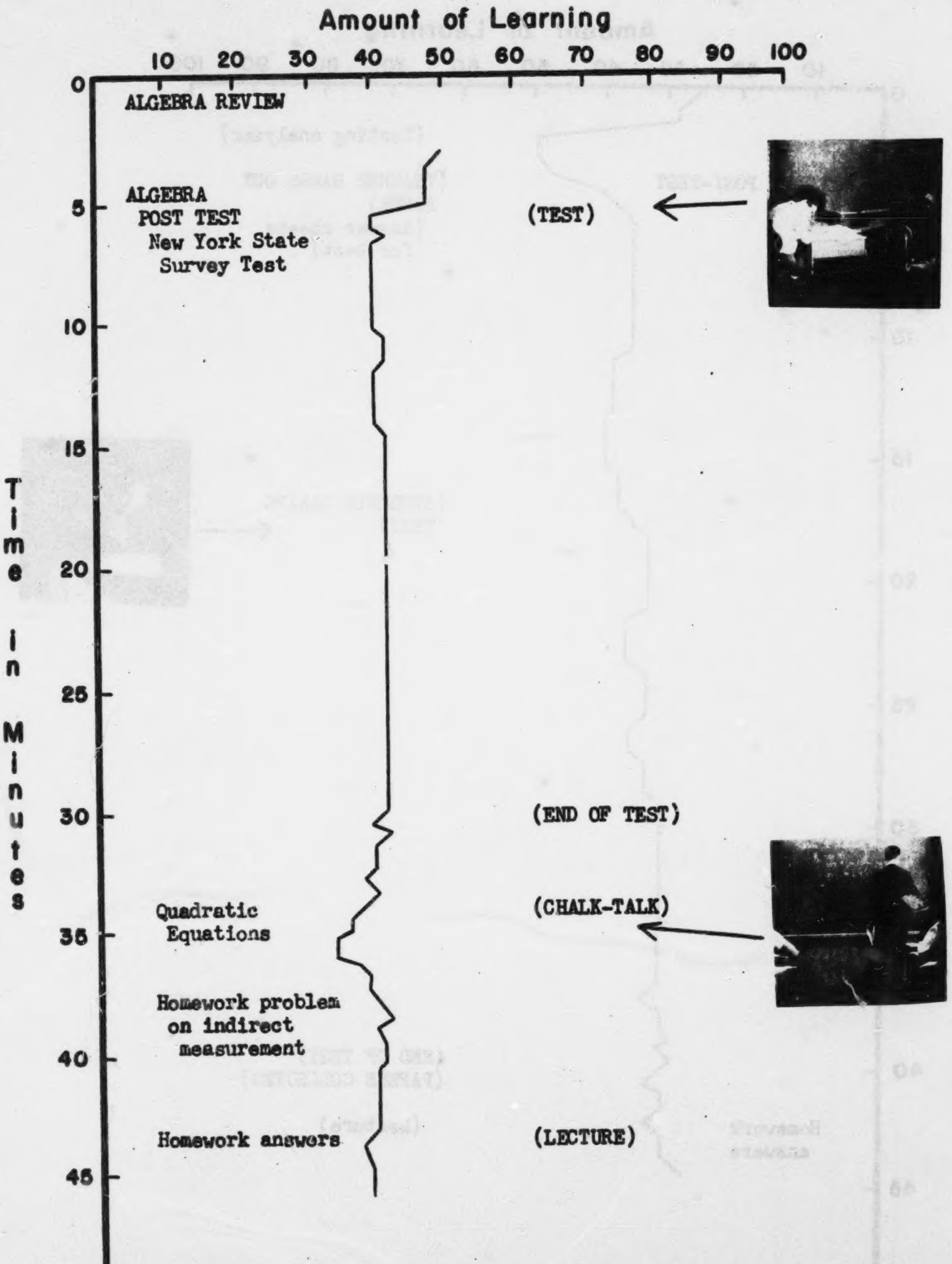

CONTROL GROUP

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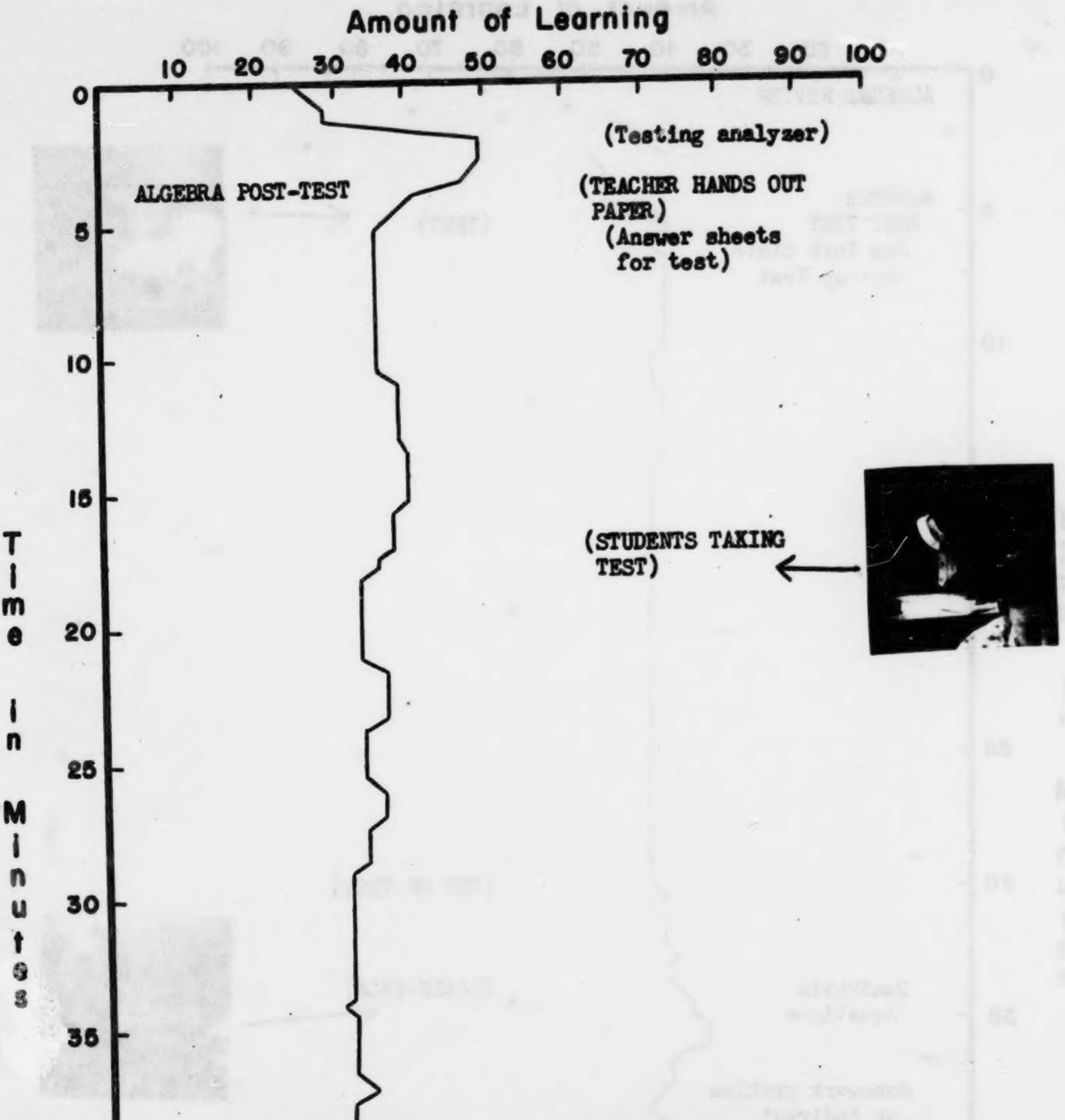

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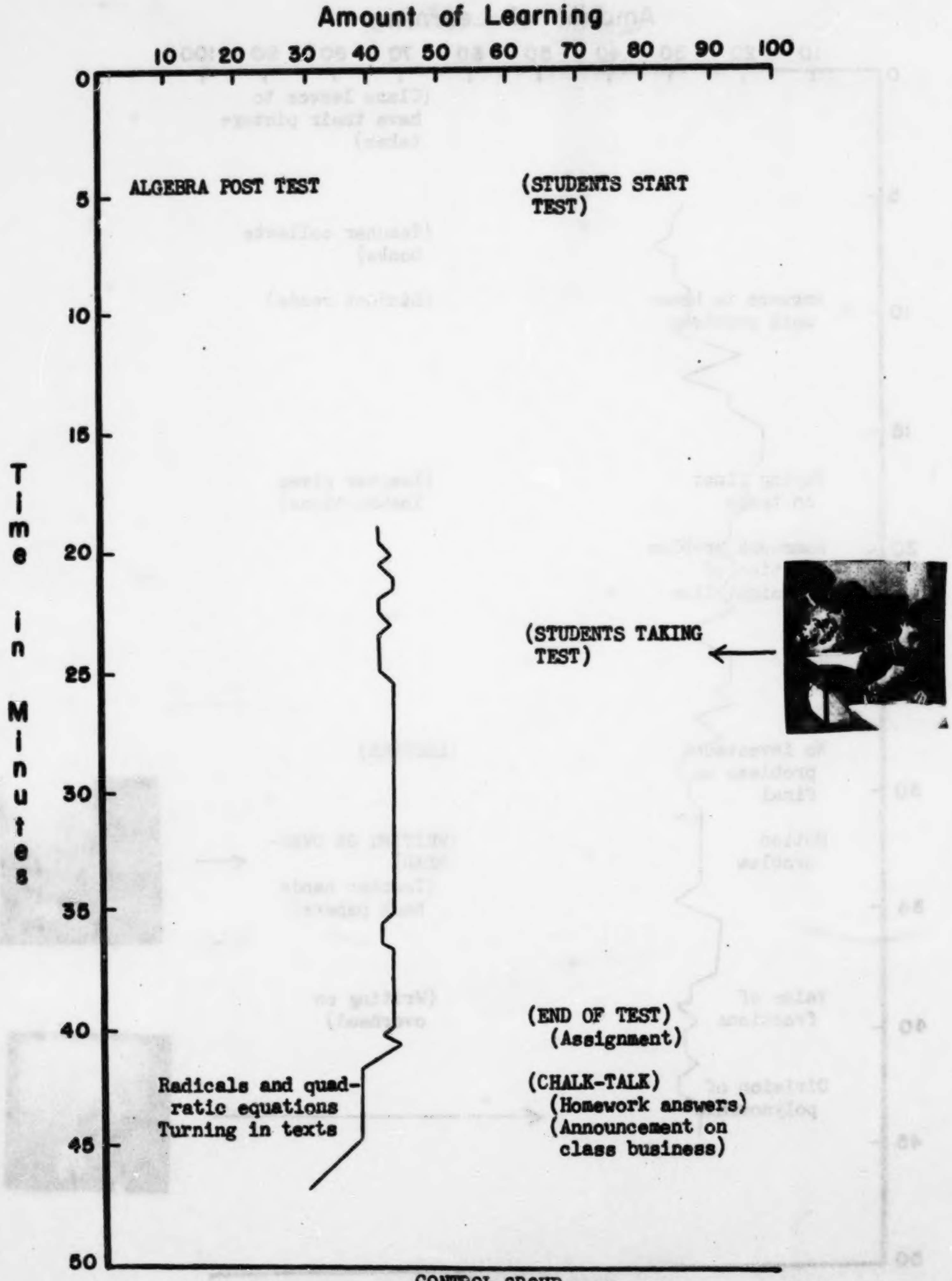

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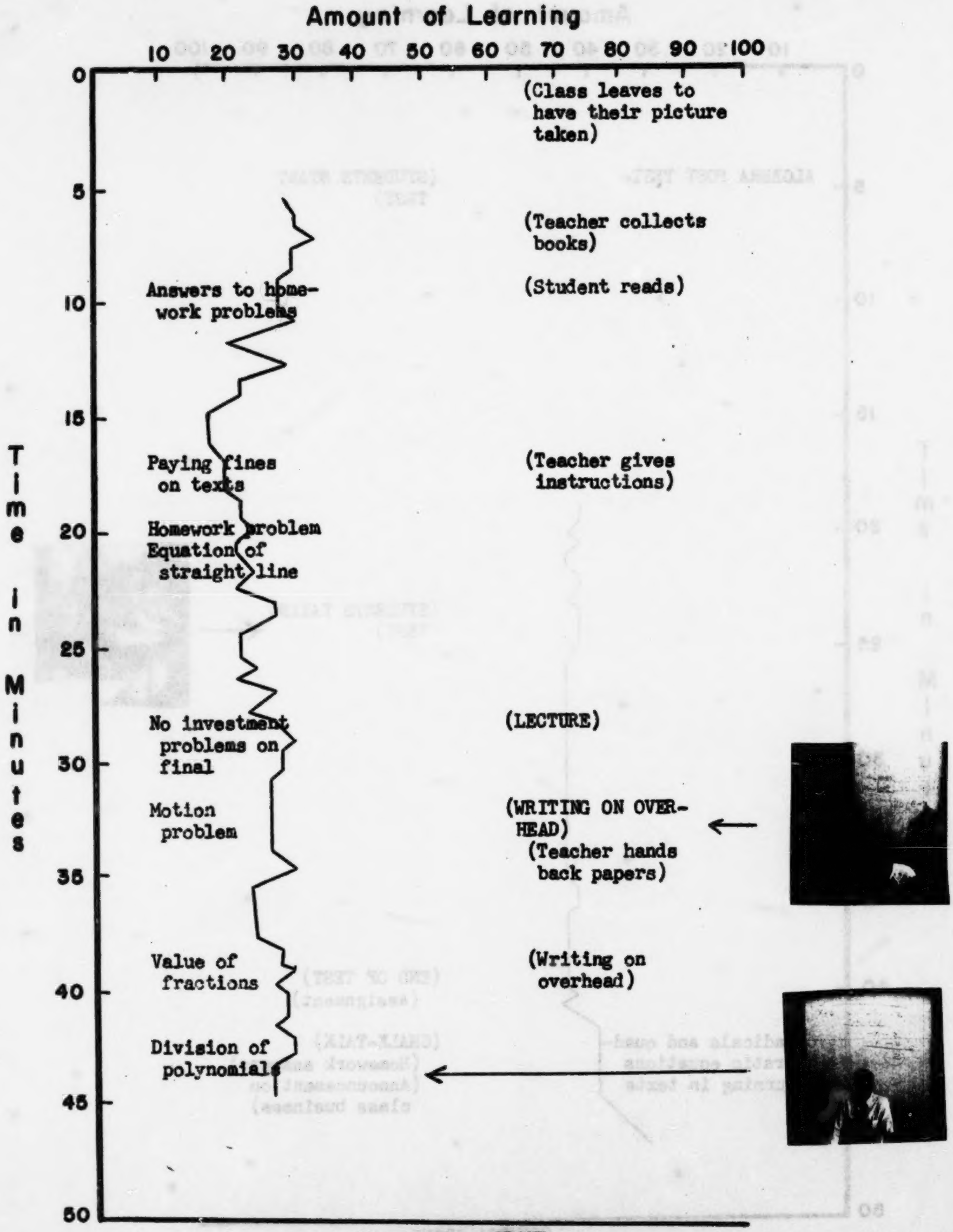

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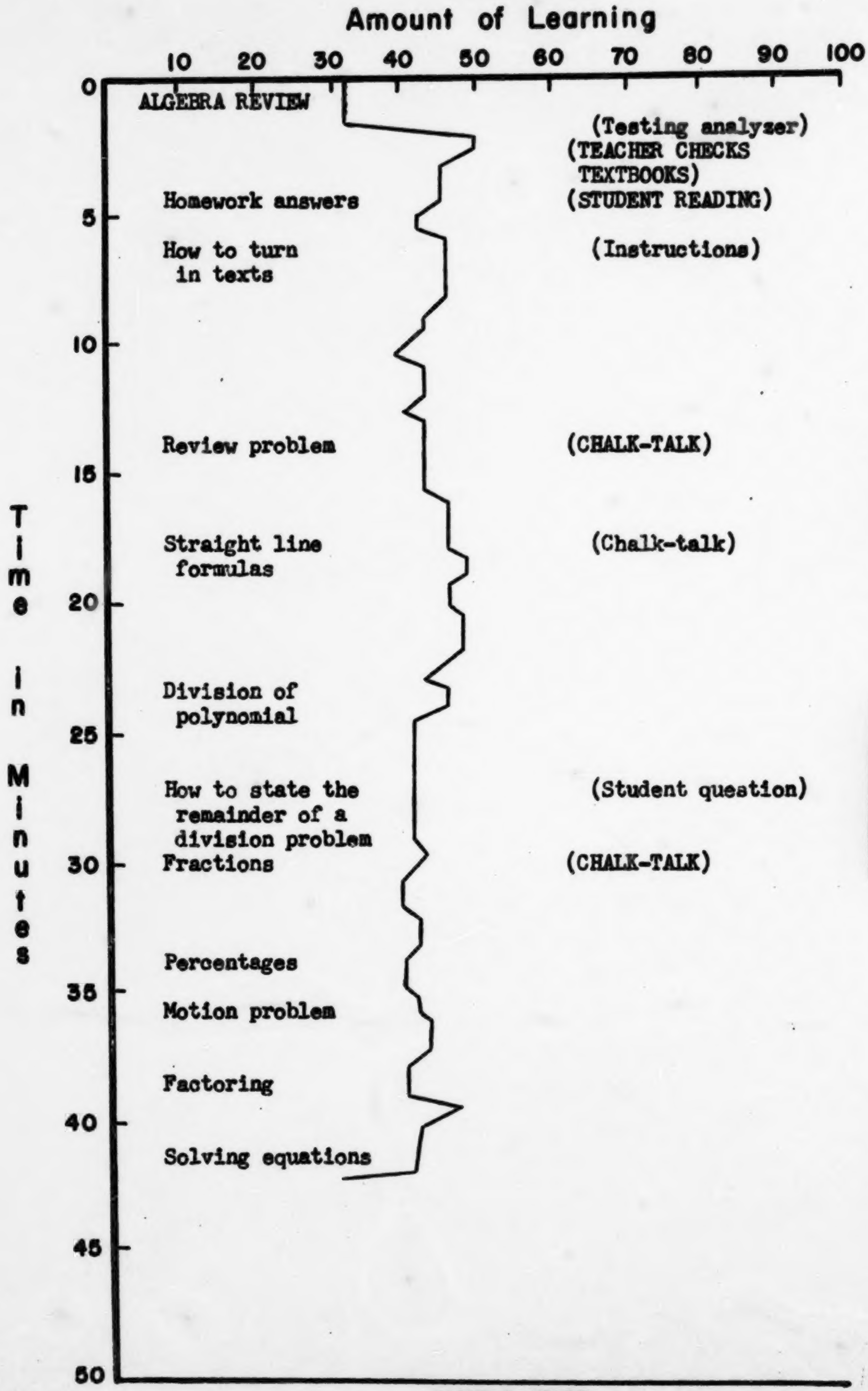

CONTROL GROUP

LEARNING PROFILE NUMBER 311